OSTRACODS FROM CALLOVIAN TO TITHONIAN SEDIMENTS OF TANZANIA, EAST AFRICA

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CONTENTS

ABSTRACT

The Upper Jurassic ostracod fauna of Tanzania is described and shown to comprise five distinct faunal assemblages each characterized by a species of *Majungaella*. Fifty-two ostracod species are recognized of which 24 are new. Four new genera, *Amicytheridea*, *Afrocytheridea*, *Mandawacythere* and *Rhadinocythere*, are described. Twenty species are retained under open nomenclature. The ostracod fauna of Tanzania is compared with that described from Madagascar, India and South Africa. At the present time two known species are common to Tanzania and South Africa, eight to Tanzania and Madagascar and five to Tanzania and India (Kutch). Fourteen are common to India and Madagascar. Incomplete sampling or lack of exposures is considered to be responsible for this numerical variation. It is anticipated that further investigations will add to the list of species common to these countries. One ostracod is also common to Tanzania and Western Australia.

The Tanzanian sequence appears to have been deposited in a shallow water, continental shelf environment ; closeness of land is evidenced by the presence of freshwater ostracods in the Middle Callovian of the Mandawa sequence.

Of the 28 ostracod genera recorded, seven are known only from the southern hemisphere (this presumes a pre-drift location for India) ; the remainder are cosmopolitan.

I. INTRODUCTION

The present research was stimulated by the receipt, from the Geological Survey of Tanganyika, of a series of samples collected through the Jurassic and Cretaceous by the field geologist W. R. Moore. The examination of this material showed that additional field collecting was necessary and an expedition to Tanzania was mounted in the summer of 1965, by the Department of Palaeontology jointly with the Geological Survey of Tanganyika.

Three regions were examined in detail : the Wami River Area, north of Dar-es-Salaam, the Central Railway Area to the south-west and the Mandawa Anticline in the south (Text-fig. 1).

The Wami River Area and the Mandawa Anticline both yielded good Upper Jurassic microfaunas but the Middle Jurassic proved to be completely barren. Exposures were not common and were largely restricted to dry stream banks, the

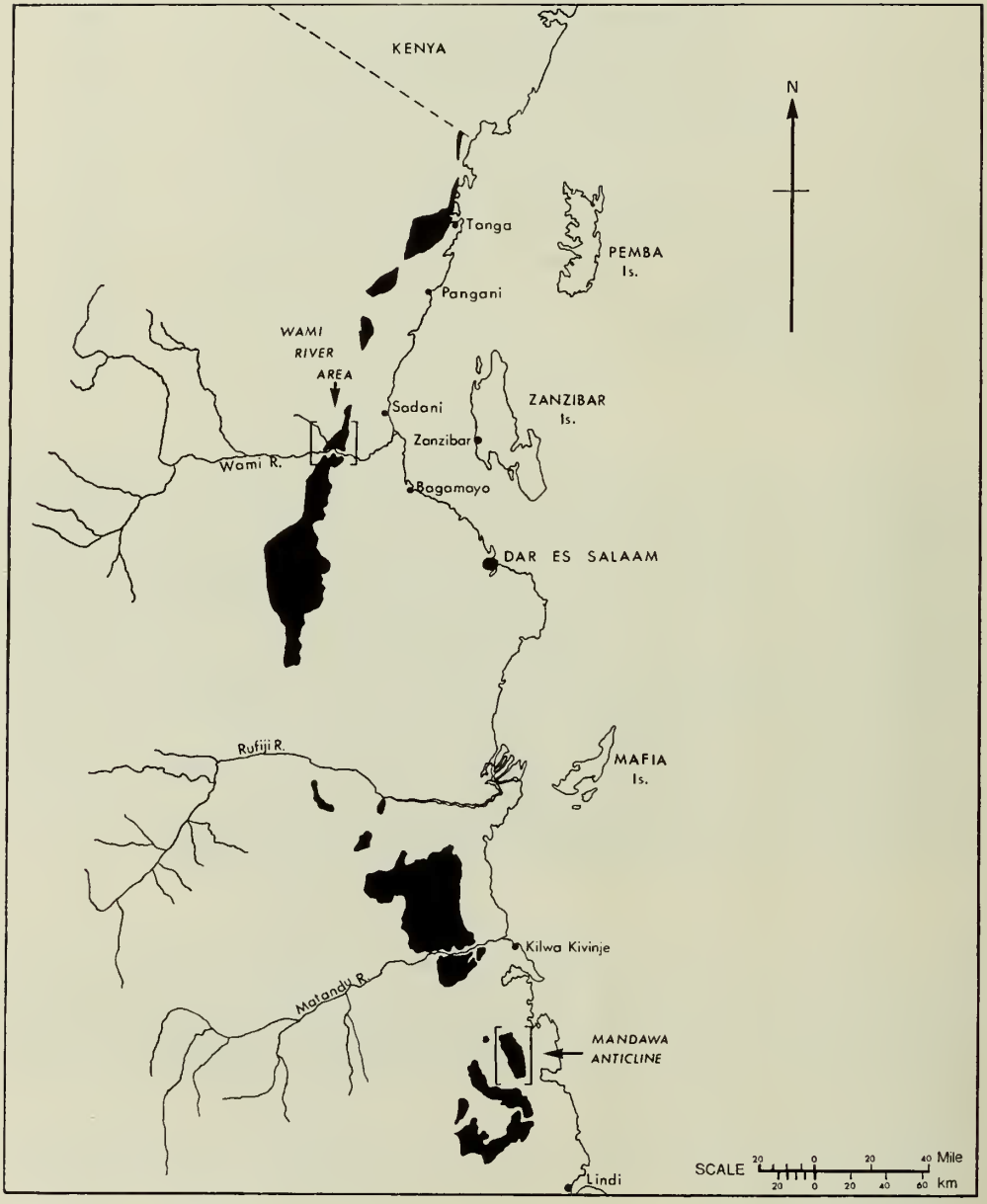

FIG. 1. Map of Tanzania to show localities and distribution of Jurassic outcrop (black).

intervening terrain being covered by thorn scrub, grassland or cultivation. The Central Railway Area was entirely unproductive and is not dealt with further. There has been no previous work undertaken on the Jurassic ostracods of Tanzania but they have been described from Madagascar (Grekoff 1963), the Majunga Basin of which appears to mirror the sediments developed in Tanzania. Although Grekoff described forty-nine ostracods in his paper only a few have so far been recognized in Tanzania. The most important of these is the genus *Majungaella*, a close relative of the European Jurassic genus *Progonocythere* Sylvester-Bradley 1948. The stratigraphical importance of *Majungaella* will be discussed later.

In addition to East Africa and Madagascar, Jurassic ostracods have been described from South Africa (Dingle 1972) and from north-west India (Ljubimova, Guha & Mohan 1960 and Guha 1975?), some species of which are common to Tanzania and from off Western Australia (Oertli 1974).

The purpose of this paper is to describe the ostracod faunas obtained from the Upper Jurassic of Tanzania and to discuss their value in correlation both within Tanzania and between other countries in the region surrounding the Indian Ocean. A preliminary paper outlining the ostracod faunal assemblages of the Tanzanian Upper Jurassic was read in Tunis (6th African Micropalaeontological Colloquium, April 1974). Subsequently a number of changes concerning the dating of the samples became necessary. The most up-to-date information is presented here.

II. STRATIGRAPHY

The Wami River Area

The geology of this region (Text-fig. 2) was published as a geological map (Quarter Degree Sheet 168) of the Bagamoyo District (Moore 1963). This map covers most of the area examined although it omits the Msata-Masugulu region in the west. Moore records some 1100 m (3600 ft) of sediment belonging to the Upper Jurassic of which 810 m (2650 ft) is dated as Upper Oxfordian – the remainder is not specified. Of the Jurassic outcrop 122 m (400 ft) is identified as Middle Jurassic.

This paper shows that definite Middle Callovian (*anceps* Zone) underlies a thick Upper Oxfordian succession. The Middle Jurassic proved to be devoid of microfossils; indeed, the arenaceous nature of the Jurassic sediments (sandy shales, sandstones and sandy limestones) has almost certainly contributed towards their absence through decalcification. Thus although Middle Callovian, Upper Oxfordian and Middle Jurassic sediments have been identified, the absence of the remaining part of the succession is more likely to be the result of lack of exposures than of non-deposition. Exposures are largely limited to dry streams with minor exposures along the banks of the Wami River in road tracks and excavations.

The following productive samples are listed in descending stratigraphical order; those prefixed 'BM' were collected by the Survey geologist W. R. Moore and those prefixed 'B' during the Museum Expedition in 1965. (Because the scale used for the eastings differs from that for the northings on the Ordnance Survey maps of Tanzania the grid references are given with four digits East and five digits North.)

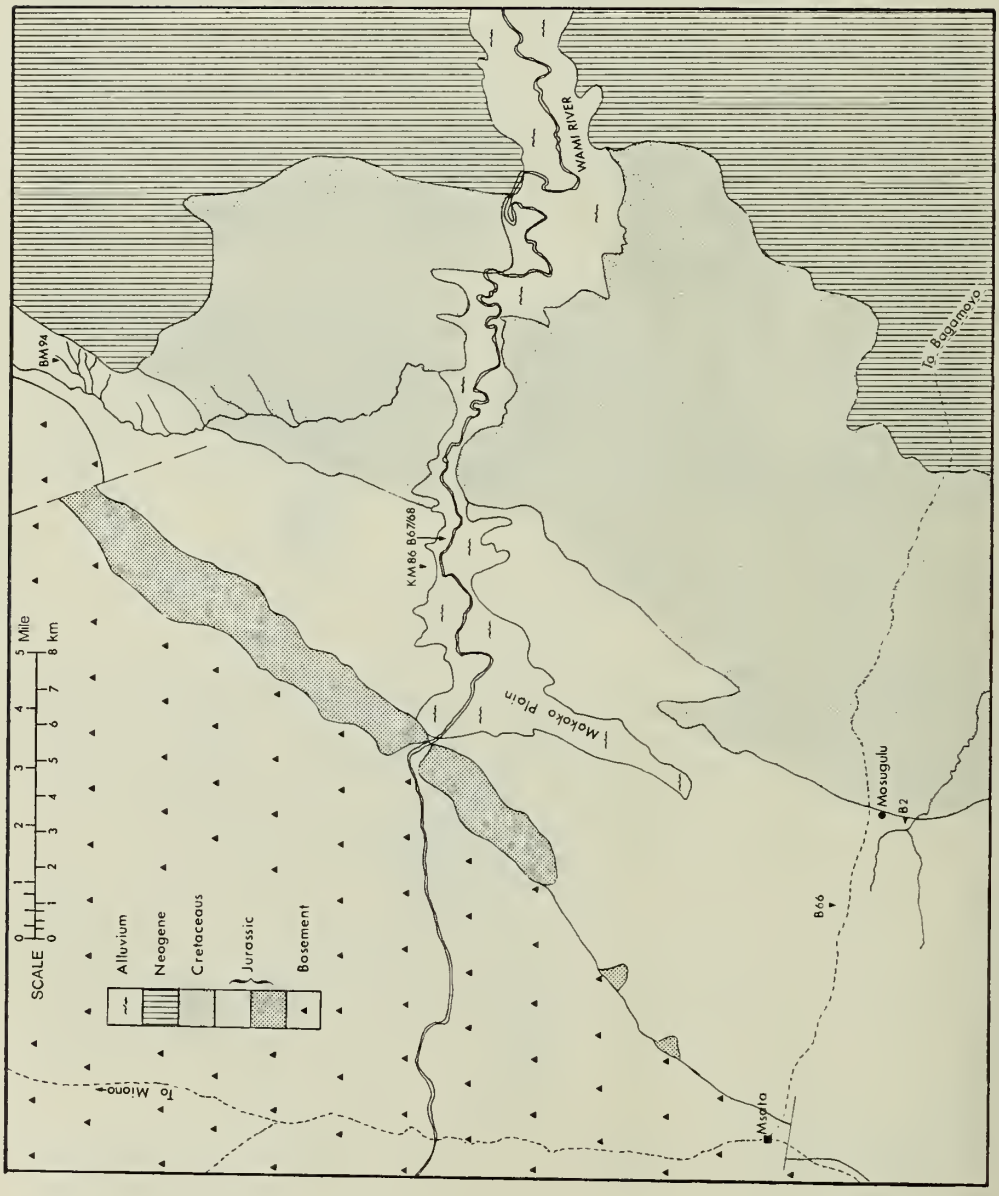

FIG. 2. Map of Wami River Area to show location of samples. Based on unpublished Tanganyika Survey Map.

Upper Oxfordian. BM50, B68–67 : micaceous siltstone exposed on the northern bank of the Wami River opposite the village of Lugoba Kinguli. Ordnance Survey Sheet 168/I ref : 4491E 93095N.

BM86 : mudstone exposed on the slip face of small hill on the northern side of Wami River. O.S. Sheet 168/I ref : 4483E 93102N.

B2 : grey shale exposed on north side of dam 0·4 km ($\frac{1}{4}$ ml) due south of Masugulu village. Dated on ammonites as belonging to the lower half of the Upper Oxfordian *transversarium* Zone (= *plicatilis* Zone of England) ; O.S. Sheet 167/IV ref : 4413E 92963N.

The index ostracod *Majungaella oxfordiana* sp. nov. is not present in all samples but by correlating B2 and B67 it would appear that the entire sequence of Oxfordian sediments is of Lower Upper Oxfordian age.

Middle Callovian. BM94 : black silty clay exposed in a stream section north of the Wami River. O.S. Sheet 168/I ref : 4538E 93200N.

B66 : grey shale exposed 0·4 km ($\frac{1}{4}$ ml) north of the Msata–Bagamoyo road 4·0 km ($2\frac{1}{2}$ ml) west of Masugulu village in a small stream section cutting through a maize field. Nodules overlying the shale contain ammonites of the Middle Callovian *anceps* Zone. O.S. Sheet 167/IV ref : 4391E 92987N.

The Mandawa Anticline

This area (Text-fig. 3) has been investigated in detail by Aitken (1961) and although all stages of the Middle and Upper Jurassic are reported as being present the succession is not continuous. Aitken also states that below the Callovian the fossils are neither abundant nor diagnostic. Certainly no microfossils were found below the Callovian ; the Pindiro Shale which forms the centre of the anticline and which is questionably of Bajocian age was disappointingly barren.

Aitken records a maximum thickness of 1200 m (3930 ft) for the Upper Jurassic and over 275 m (900 ft) for the Middle Jurassic.

Exposures are, as in the Wami River Area, largely restricted to dry stream beds and even so are not common. Furthermore, the high proportion of arenaceous material has ensured that decalcification of the surface outcrop has largely removed the microfossils. A large proportion of the samples collected therefore proved to be barren. The following contained good faunas and are listed in descending stratigraphical order :

Tithonian. B110–111 : brown and green marl interbedded with thin siltstone bands exposed in the right bank of the Nalwehe stream, just below Aitken locality 2179. This horizon is high in the Tithonian sequence and, according to Dr N. J. Morris (personal communication), could even be Berriasian in age. A precise age is not assignable, however, and an Upper Tithonian dating would appear to be acceptable. This is to some extent confirmed by the presence of the Tithonian ostracod *Majungaella perforata* Grekoff and the absence of the Tithonian–Lower Cretaceous *Majungaella nematis* Grekoff, but no categorical statement concerning the age is possible at this time.

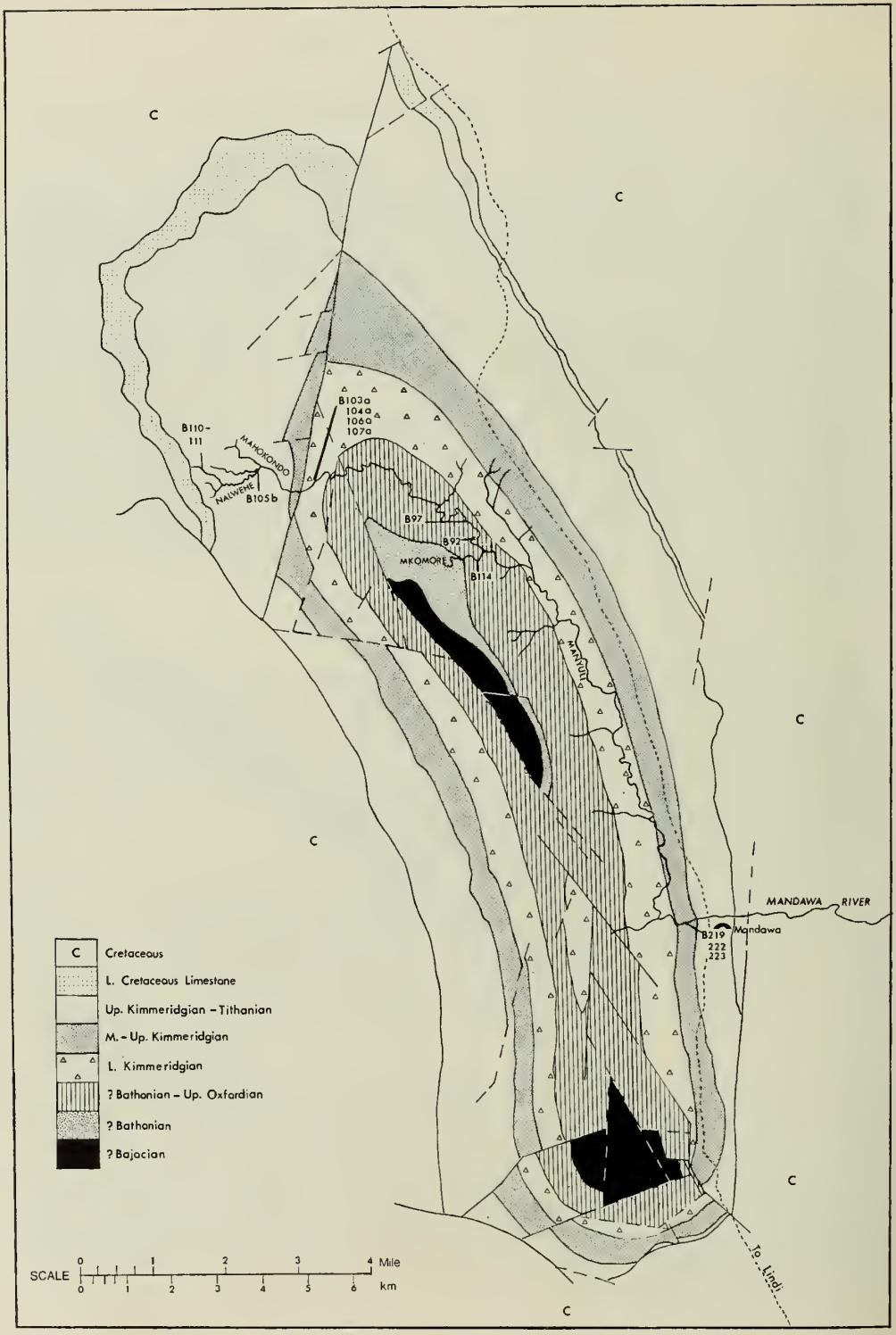

FIG. 3. Map of Mandawa Anticline to show location of samples. After Aitken (1961).

B105B : buff siltstone with interbedded siltstone nodules, exposed about 1·6 km (1 ml) downstream from B110–111 ; Nalwehe stream. The most accurate dating here would be (?) Lower Tithonian.

Middle or Upper Kimmeridgian. B219–223 : grey silty shale exposed on left bank of the Mandawa River just upstream of Mandawa village ; Aitken locality 794. It is not possible to be more precise concerning the age of this sequence which occurs above the level dated as Middle or Upper Kimmeridgian by Aitken (1961), from which he obtained the bivalves *Trigonia* (*Indotrigonia*) *mandawae* and *T.* (*Indotrigonia*) *tanganyicensis*, and below the Tithonian horizon of his *T.* (*Indotrigonia*) *vstriata* and *T.* (*Indotrigonia*) *africana*.

Lower Kimmeridgian. B103a–107a : dark grey shale with siltstone nodules exposed in high left bank of the Manyuli stream 183 m (200 yds) west of Aitken locality 2159. This sequence, which is particularly well exposed, has been accurately dated on associated ammonites as Lower Kimmeridgian.

Middle Callovian (*anceps* Zone = B66 and BM94 of the Wami River Area). B92 : buff sandy limestone weathering to yellow sandstone, shelly and oolitic. Aitken locality 2219 ; Manyuli stream.

B97 : grey sand shales with thin sandstone bands, some with shells. Right bank of the Manyuli stream.

B114 : greenish-buff soft flaggy sandstone containing shells, exposed in right bank of the Mkomore stream.

III. SYSTEMATIC DESCRIPTIONS

All specimens described have been deposited in the collections of the Palaeontology Department, British Museum (Natural History). Unless otherwise stated, the number of specimens recorded for each species refers only to those separately mounted and catalogued. Additional material is available in the faunal slide collection.

Order PODOCOPIDA Müller 1894

Suborder PLATYCOPINA Sars 1866

Family **CYTHERELLIDAE** Sars 1866

Genus ***CYTHERELLA*** Jones 1849

Cytherella cf. ***collapsa*** Grekoff 1963

Pl. 1, fig. 11

Material. A single specimen, Io.5821, sample B66.

Horizon and Locality. Middle Callovian ; sample B66, Wami River Area, north of the Msata–Bagamoyo road (Text-fig. 2).

Discussion. Grekoff records *Cytherella collapsa* from the Middle Callovian of Madagascar. In Tanzania a form very close to *C. collapsa* commonly occurs in the Middle Callovian but differs in having the median constriction of the carapace, as seen in side view, less positively developed. *C. collapsa* also tends to be more broadly

rounded at its posterior end than does the Tanzanian material although variations here suggest that this may not be significant. At this time it is preferred not to identify the Tanzanian species directly with *C. collapsa*, but when the range of variation becomes known this may be necessary.

Dimensions. Io.5821, left valve (Pl. 1, fig. 11), length 0·64 mm ; height 0·32 mm.

Cytherella knysnaensis Dingle 1972

Pl. 1, figs 1, 5

1972 *Cytherella knysnaensis* Dingle : 289 ; pl. 15f–h.

Material. Two specimens, Io.6021–2, sample B97.

Horizon and Locality. Middle Callovian ; samples B92 and B97, Manyuli stream and sample B114, Mkomore stream, Mandawa Anticline (Text-fig. 3).

Discussion. *Cytherella knysnaensis* is associated in the Callovian of the Knysna outlier (Cape Province, South Africa) with *Cytherelloidea brentonensis* Dingle. The marine facies containing these ostracods is interbedded with non-marine sediments and Dingle considers the sequence to represent a near-shore environment. In the Mandawa Anticline *Cytherella knysnaensis* is also associated with *Cytherelloidea brentonensis*, together with *Darwinula* sp. and charophytes, indicating a near-shore environment with some freshwater influence.

Further north in the Wami River Area the Callovian appears to be more marine and here the species of *Cytherella* are *C. masuguluensis* sp. nov. and *C.* cf. *collapsa* Dingle. Possibly the change in the species present is a reflection on the environment, the northern outcrop representing more saline conditions.

Dimensions. Io.6021, carapace (Pl. 1, fig. 1), length 0·80 mm ; height 0·42 mm ; width 0·32 mm. Io.6022, carapace (Pl. 1, fig. 5), length 0·82 mm ; height 0·45 mm ; width 0·37 mm.

Cytherella mandawaensis sp. nov.

Pl. 1, figs 3, 4, 7–9

Diagnosis. *Cytherella* with elongate carapace ; dorsal margin arched just behind muscle scar depression.

Holotype. Io.6023, carapace, sample B223 (Pl. 1, fig. 3).

Paratypes. Io.6024–8, samples B219 and B223.

Horizon and Locality. Middle or Upper Kimmeridgian ; samples B219 and B223, Mandawa River (Text-fig. 3.)

Discussion. As for all species of *Cytherella* the important diagnostic feature is the carapace outline. The smaller left valve is more angularly arched posterodorsally than is the larger right valve, while the central muscle scar depression is either positively developed (Pl. 1, fig. 7) or almost imperceptible (Pl. 1, fig. 3). *Cytherella mandawaensis* sp. nov. differs from *C. collapsa* Grekoff in lacking the median

constrictions and broadly rounded ends of that species. It also differs from *C. umbilica* sp. nov. in that it does not have the deeply recessed muscle scar depression of the latter.

DIMENSIONS. Holotype, Io.6023, carapace, length 0·68 mm ; height 0·37 mm ; width 0·21 mm. Paratypes : Io.6025, left valve (Pl. 1, fig. 8), length 0·63 mm ; height 0·34 mm. Io.6026, right valve (Pl. 1, fig. 7), length 0·68 mm ; height 0·39 mm. Io.6027, right valve (Pl. 1, fig. 4), length 0·70 mm ; height 0·41 mm. Io.6028, carapace (Pl. 1, fig. 9), length 0·68 mm ; height 0·37 mm ; width 0·24 mm.

Cytherella masuguluensis sp. nov.

Pl. 1, figs 2, 10

DIAGNOSIS. *Cytherella* with rectangular lateral outline.

HOLOTYPE. Io.6029, carapace, sample B66 (Pl. 1, fig. 2).

PARATYPES. Io.6030–1, samples B66 and BM94.

HORIZON AND LOCALITY. Middle Callovian, samples B66 and BM94, Wami River Area (Text-fig. 2).

DISCUSSION. *Cytherella masuguluensis* sp. nov. has a rather simple rectangular outline which lacks the dorsal and ventral concavities of *C. collapsa* Grekoff. It is also not so elongate as *C. mandawaensis* sp. nov. nor so slender in dorsal view. Indeed the dorsal outlines of *C. masuguluensis*, *C. mandawaensis* and *C. knysnaensis* reveal the wide variations existing between these three species.

DIMENSIONS. Holotype, Io.6029, carapace, length 0·72 mm ; height 0·43 mm ; width 0·30 mm. Paratype, Io.6030, carapace (Pl. 1, fig. 10), length 0·68 mm ; height 0·37 mm ; width 0·30 mm.

Cytherella umbilica sp. nov.

Pl. 1, figs 12–14

DIAGNOSIS. *Cytherella* having rounded oval carapace and deeply incised muscle scar depression.

HOLOTYPE. Io.6032, right valve, sample B67 (Pl. 1, fig. 13).

PARATYPES. Io.6033–5, sample B67.

HORIZON AND LOCALITY. Upper Oxfordian, samples B67, B68 and BM86, Wami River Area (Text-fig. 2).

DISCUSSION. *Cytherella umbilica* sp. nov. is very readily distinguished from other *Cytherella* species by its deep muscle scar depression and oval carapace outline. The preservation of the material is such that all specimens have adhering quartz grains which it is impossible to remove without damaging the shell.

DIMENSIONS. Holotype, Io.6032, right valve, length 0·53 mm ; height 0·36 mm. Paratypes : Io.6033, left valve (Pl. 1, fig. 12), length 0·65 mm ; height 0·40 mm. Io.6034, right valve (Pl. 1, fig. 14), length 0·82 mm ; height 0·43 mm.

Cytherella sp.

Pl. 1, fig. 6

MATERIAL. A single left valve, Io.6036, from sample B105b.

HORIZON AND LOCALITY. (?) Lower Tithonian, sample B105b, Mandawa Anticline (Text-fig. 3).

DISCUSSION. Although of rather striking appearance the preservation of the ostracod belonging to this uncommon species is such that the erection of a new species is undesirable.

DIMENSIONS. Io.6036, left valve, length 0·75 mm ; height 0·38 mm.

Genus *CYTHERELLOIDEA* Alexander 1929

Species of this genus are not commonly found in the Jurassic of Tanzania – their place appears to be taken by species of *Cytherella.*

Cytherelloidea brentonensis Dingle 1972

Pl. 2, fig. 1

1972 *Cytherelloidea brentonensis* Dingle : 290 ; pl. 16a–c.

MATERIAL. A single specimen, Io.6037, sample B97.

HORIZON AND LOCALITY. Middle Callovian, sample B97, Mandawa Anticline (Text-fig. 3).

DISCUSSION. *Cytherelloidea brentonensis* Dingle was first recorded from possible Callovian sediments of the Knysna Outlier, South Africa. Only one specimen has so far been found in the Tanzanian succession and this lacks the marginal dentition of the species. However, the ostracod is otherwise comparable and is regarded as being conspecific.

DIMENSIONS. Io.6037, carapace, length 0·55 mm ; height 0·32 mm ; width 0·13 mm.

Cytherelloidea sp.

Pl. 1, fig. 15

MATERIAL. Two specimens, Io.6038–9, samples B219 and B107a. Io.6039 figd. Pl. 1, fig. 15.

HORIZON AND LOCALITY. Lower to Middle or Upper Kimmeridgian, samples B107a and B219, Mandawa Anticline (Text-fig. 3).

DISCUSSION. A very rare species represented by two single valves and characterized by a sigmoid central rib enclosed by a peripheral ridge. The Upper Cretaceous *Cytherelloidea umzambaensis* Dingle 1969 is close to this species but instead of the median rib forming a V below the muscle scar depression, as in *Cytherelloidea*

sp., the rib in *C. umzambaensis* has a much sharper right-angled bend and a straight course below the muscle scar depression.

Dimensions. Io.6039, left valve, length 0·65 mm ; height 0·34 mm.

Suborder PODOCOPINA Sars 1866

Superfamily **BAIRDIACEA** Sars 1888

Family **BAIRDIIDAE** Sars 1888

Genus ***BAIRDIA*** McCoy 1844

Representatives of the genus *Bairdia* are only rarely found in the Jurassic sediments examined, possibly owing to an unfavourable environment. Precise reasons for this are, however, at present uncertain.

Bairdia sp. A

Pl. 2, fig. 14

Material. A single specimen, Io.6040, sample B223.

Horizon and Locality. Middle or Upper Kimmeridgian, samples B219 and B223, Mandawa Anticline (Text-fig. 3).

Discussion. Of the two juvenile specimens found of this species only the figured specimen has a terminal posterior spine on each valve. The absence of adult specimens presents a situation often encountered in the Lower Jurassic of England. No precise reasons for this are known but it may indicate that the species did not live in that particular area and only juvenile instars were brought in by current action.

Dimensions. Io.6040, carapace, length 0·29 mm ; height 0·18 mm ; width 0·14 mm.

Bairdia sp. B

Text-fig. 4 (overleaf)

Material. A single specimen, Io.6041, sample B68.

Horizon and Locality. Upper Oxfordian, samples B2 and B68, Wami River Area (Text-fig. 2).

Discussion. Only a single adult specimen, a broken right valve, has been found of this species although a number of small juvenile instars are considered to be conspecific. The figured specimen (Io.6041) has rather large, shallow pits ornamenting the central part of the valve but there is insufficient material available to name the species.

Bairdia sp. C

Pl. 2, figs 9, 13

Material. Two specimens, Io.6042–3, samples B97 and B114 respectively.

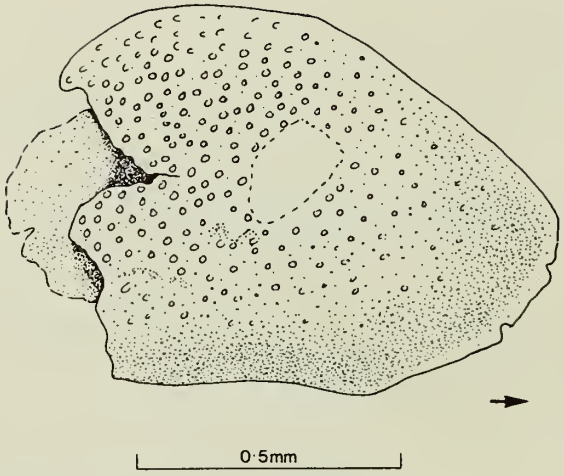

Fig. 4. *Bairdia* sp. B. Broken right valve, Io.6041.

Horizon and Locality. Middle Callovian, samples B97 and B114, Wami River Area (Text-fig. 2).

Discussion. Two complete specimens and a number of fragmentary specimens have been obtained. The single juvenile instar (Io.6043) may not be conspecific but is retained here for the present. Adult specimens do not possess the surface pitting of *Bairdia* sp. B and are further contrasted by the presence of upturned anterior and posterior ends.

Dimensions. Io.6042, carapace (Pl. 2, fig. 13), length 0·82 mm ; height 0·46 mm ; width 0·34 mm. Io.6043, juvenile carapace (Pl. 2, fig. 9), length 0·50 mm ; height 0·29 mm ; width 0·21 mm.

Genus ***BYTHOCYPRIS*** Brady 1880

The genus *Bythocypris* has not previously been recognized from the Mesozoic sediments of the Indian Ocean region. Although very rare, two distinct species are recognized here but left under open nomenclature.

Bythocypris sp. A

Pl. 2, fig. 8

Material. A single specimen, Io.6044, sample B219.

Horizon and Locality. Middle or Upper Kimmeridgian, sample B219, Mandawa Anticline (Text-fig. 3).

Discussion. A single left valve characterized by having an elongate carapace with almost straight ventral margin and arched dorsal margin having distinct cardinal angles.

Dimensions. Io.6044, left valve, length 0·74 mm ; height 0·39 mm.

Bythocypris sp. B

Pl. 2, fig. 7 ; Text-fig. 5a, b

Material. Two specimens, Io.6045–6, samples B67 and B68 respectively.

Horizon and Locality. Upper Oxfordian, samples BM86, B67 and B68, Wami River Area (Text-fig. 2).

Discussion. A rare ostracod present in three of the Oxfordian samples. *Bythocypris* sp. B differs from sp. A in being more squat in outline with well-rounded terminal margins. The ventral margin being incurved medially differs from the almost straight ventral margin of sp. A ; the dorsal margin also differs in lacking the acute posterior cardinal angle and as a result is more uniformly arched.

Dimensions. Io.6045, carapace (Pl. 2, fig. 7), length 0·70 mm ; height 0·36 mm ; width 0·28 mm. Io.6046, carapace (Text-fig. 5), length 0·71 mm ; height 0·43 mm ; width 0·31 mm.

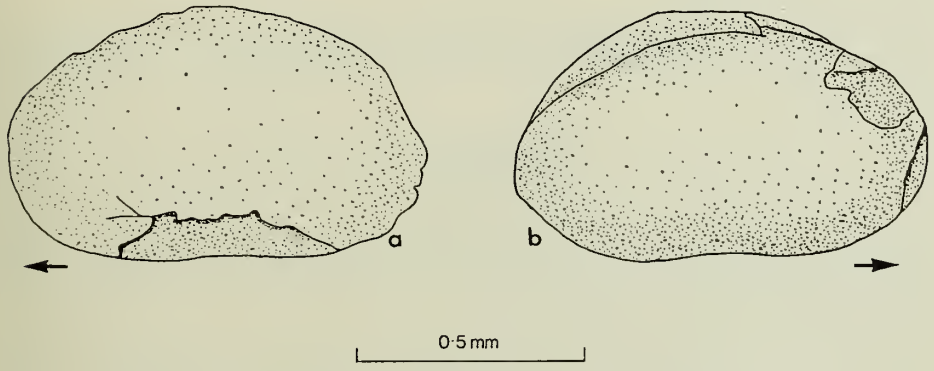

Fig. 5a, b. *Bythocypris* sp. B. Left and right views, carapace Io.6046.

Superfamily **CYPRIDACEA** Baird 1845

Family **PARACYPRIDIDAE** Sars 1923

Genus ***PARACYPRIS*** Sars 1866

Paracypris aff. ***P. contermia*** Ljubimova & Mohan 1960

Pl. 2, fig. 6

Material. A single specimen, Io.6047, sample B66.

Horizon and Locality. Middle Callovian, sample B66, Wami River Area (Text-fig. 2).

Discussion. A very rare ostracod rather more elongate in outline than the *Paracypris contermia* described by Ljubimova & Mohan from the Callovian of Kutch, but which nevertheless has a close affinity with that species. If additional material had been available possibly the Tanzanian material could have been recognized as conspecific.

Dimensions. Io.6047, carapace, length 0·55 mm ; height 0·24 mm ; width 0·17 mm.

Paracypris sp. A

Pl. 2, figs 4, 5

Material. Two specimens, Io.6048–9, sample B223.

Horizon and Locality. Middle or Upper Kimmeridgian, samples B219 and B223, Mandawa Anticline (Text-fig. 3).

Discussion. *Paracypris* sp. A is a rare ostracod too poorly preserved to identify specifically. It is, however, close to *P.* cf. *acris* Oertli of Grekoff 1963 although it is not so elongate and has a more oblique antero-dorsal slope in the right valve. The two forms are specifically distinct but both belong to that group of *Paracypris* species having a very sharply pointed posterior end and a line of greatest length extending along the ventral margin.

Dimensions. Io.6048, carapace (Pl. 2, fig. 5), length 0·72 mm ; height 0·35 mm ; width 0·26 mm. Io.6049, carapace (Pl. 2, fig. 4), length 0·77 mm ; height 0·33 mm ; width 0·28 mm.

Paracypris sp. B

Pl. 2, fig. 2

Material. A single specimen, Io.6050, sample BM94.

Horizon and Locality. Middle Callovian to Upper Oxfordian, samples BM94 and B2, Wami River Area (Text-fig. 2).

Discussion. Smaller than *Paracypris* sp. A and with a much longer antero-dorsal slope, the line of greatest height being further back and almost median in position. As the illustrations show, there is no difficulty in distinguishing between these two species and here again there is insufficient material to identify the species specifically.

Dimensions. Io.6050, carapace, length 0·54 mm ; height 0·22 mm ; width 0·13 mm.

Genus *PONTOCYPRELLA* Ljubimova 1955

Pontocyprella sp.

Pl. 2, figs 15–17

Material. Five registered specimens, Io.6051–5, sample B223, of which Io.6052 and 6055 are not here figured.

Horizon and Locality. Middle or Upper Kimmeridgian, samples B219 and B223, Mandawa Anticline (Text-fig. 3).

Discussion. A total of eight juvenile instars and a single adult carapace are retained here under open nomenclature. This species differs from the Callovian

Pontocyprella sp. of Grekoff 1963 in having a much straighter ventral margin along which the line of greatest length is situated. The dorsal margin is also less strongly arched in the present material.

Dimensions. Io.6051, left valve (Pl. 2, fig. 16), length 0·43 mm; height 0·20 mm. Io.6053, carapace (Pl. 2, fig. 17), length 0·41 mm ; height 0·20 mm ; width 0·16 mm. Io.6054, right valve (Pl. 2, fig. 15), length 0·35 mm ; height 0·17 mm. Io.6055, adult carapace, length 0·56 mm ; height 0·26 mm ; width 0·24 mm.

Superfamily **DARWINULACEA** Brady & Norman 1889

Family **DARWINULIDAE** Brady & Norman 1889

Genus ***DARWINULA*** Brady & Robertson 1885

Darwinula sp.

Pl. 2, fig. 12

Material. A single specimen, Io.6056, sample B114.

Horizon and Locality. Middle Callovian, sample B114, Mandawa Anticline (Text-fig. 3).

Discussion. A single carapace in a rather poor state of preservation but distinguishable from the Middle Jurassic *Darwinula* sp. of Grekoff 1963 by its long elongate carapace, lacking the curved dorsal and ventral margins of the latter. The presence of *Darwinula*, together with charophytes, in an otherwise marine environment, indicates a near-shore environment subject to some freshwater influence.

Dimensions. Io.6056, carapace, length 0·85 mm ; height 0·37 mm ; width 0·31 mm.

Superfamily **CYTHERACEA** Baird 1850

Family **BYTHOCYTHERIDAE** Sars 1926

Genus ***MONOCERATINA*** Roth 1928

Monoceratina sp. A

Pl. 2, figs 10, 11

Material. Two specimens, Io.6057–8, sample B219.

Horizon and Locality. Middle or Upper Kimmeridgian, samples B219 and B223, Mandawa Anticline (Text-fig. 3).

Discussion. A rare species having some feature in common with the Portlandian/Valanginian *Monoceratina* 129 of Grekoff 1963 from Madagascar, but differing in lacking the coarse surface pitting of that species. *Monoceratina* sp. A would appear to be new and, so far, known only from the Middle or Upper Kimmeridgian.

Dimensions. Io.6057, carapace (Pl. 2, fig. 10), length 0·71 mm ; height 0·43 mm ; width 0·35 mm. Io.6058, carapace (Pl. 2, fig. 11), length 0·71 mm ; height 0·39 mm ; width 0·28 mm.

Monoceratina sp. B

Pl. 2, fig. 3

Material. A single specimen, Io.6059, sample B97.

Horizon and Locality. Middle Callovian, sample B97, Mandawa Anticline (Text-fig. 3).

Discussion. A strongly sulcate, highly ornamented species of *Monoceratina* for which there is no comparable form from the Indian Ocean region. The nearest species is *M. scrobiculata* Triebel & Bartenstein 1938 from the Lower Jurassic of Europe but this differs by having the coarse pitting covering the entire surface of the valve rather than being restricted to the central part as in *M.* sp. B. *M. scrobiculata* also differs in having the line of greatest length situated higher up on the valve, passing along the dorsal margin rather than through the mid-point as in *M.* sp. B.

Dimensions. Io.6059, left valve, length 0·49 mm ; height 0·24 mm.

Family **PROGONOCYTHERIDAE** Sylvester-Bradley 1948

Subfamily **PROGONOCYTHERINAE** Sylvester-Bradley 1948

The genera placed in this subfamily are all related on carapace outline, which is subquadrate to subrectangular with rounded anterior and triangular posterior ends and with the ventro-lateral part of the valve tending to overhang the venter. Internally the duplicature is of medium width without a vestibule. Marginal pore canals are simple, generally straight but may be slightly curved and relatively few in number. Normal pore canals are of simple type although sieve plates are known in some genera. Muscle scars consist of a subvertical row of four oval adductor scars with a rounded or slightly crescentic antero-dorsal frontal scar and a rounded antero-ventral mandibular scar. Hinge types are variable, ranging from lophodont to entomodont.

Genus *MAJUNGAELLA* Grekoff 1963

The genus *Majungaella* was first described by Grekoff from the Upper Jurassic and Lower Cretaceous of Madagascar ; the type species, *M. perforata* Grekoff, ranges from the Kimmeridgian to the Portlandian. Grekoff (1963) also described a second species from Madagascar, *M. nematis*, which has a range of Portlandian to Valanginian. Subsequently species of *Majungaella* have been described from the Mesozoic of India (Guha 1975?), East Africa (Bate 1969), South Africa (Dingle 1971, 1972) and from Australia (Bate 1972).

Dingle (1972) considered *Majungaella* to be a subgenus of the almost exclusively northern hemisphere genus *Progonocythere* Sylvester-Bradley 1948. *Progonocythere* sensu stricto is certainly very close to *Majungaella* in that it has a comparable carapace outline and the same type of hinge and muscle scar arrangement. The details of the duplicature also agree, although the marginal pore canals differ slightly in number and shape. *Progonocythere* has 6–10 straight anterior marginal canals whereas in *Majungaella* the canals are slightly curved and increase in number from

14–20 in the Jurassic to 28–30 in the Cretaceous. *Majungaella* may be further differentiated by its surface sculpture of pits often concentrically arranged. Because of these differences, consistent for all species, the two are retained here as distinct genera.

Progonocythere has a stratigraphical range restricted to the Jurassic and a geographical range virtually restricted to the region north of the Tethys. South of the Tethys, the southern genus *Majungaella* appears in the Middle Jurassic and ranges through into the Upper Cretaceous.

Recently, Krömmelbein (1975) has removed from *Majungaella* those Upper Cretaceous species having an increased number of anterior marginal pore canals and a distinctly angled but narrow posterior end. These forms he has placed in the new genus *Tickalaracythere*. Rossi de Garcia (1972) has described *Novocythere*, an Upper Cretaceous genus from Argentina, which from the illustrations appears to be synonymous with *Tickalaracythere*. Krömmelbein (personal communication) informs me that Rossi de Garcia has written to him stating that the hinge of *Novocythere* is not the same and that the expanded portion of the median element is to the rear of the hinge. This is not correct according to the illustrations of Rossi de Garcia. There is, therefore, some taxonomic confusion which can only be cleared up by examining Rossi de Garcia's material from Argentina and by comparing it with material from Australia placed by Krömmelbein in *Tickalaracythere*. It is not my intention here to revise the genus *Majungaella*, but on present evidence I would prefer to retain *Tickalaracythere* or *Novocythere*, or both, as subgenera of *Majungaella*.

Majungaella perforata Grekoff 1963

Pl. 3, figs 1–3, 7

1963 *Majungaella perforata* Grekoff : 1743 ; pl. 5, figs 134–140 ; pl. 9, figs 230, 233.

Material. Six specimens, Io.6060–5, samples B105b, B110 and B111.

Horizon and Locality. (?) Lower to Upper Tithonian, samples B105b, B110 and B111, Mandawa Anticline (Text-fig. 3).

Discussion. Grekoff (1963) records *M. perforata* from the Kimmeridgian and Portlandian of Madagascar while Guha (1975?) records it from the Callovian to Kimmeridgian of Kutch. This last recorded range would appear to be excessive as the present investigation shows species of *Majungaella* to be more restricted than this. In Tanzania *M. perforata* has been found in the (?) Lower and Upper Tithonian but below this it is replaced by the Middle or Upper Kimmeridgian *M. praeperforata* sp. nov., a closely related and similar species. The Tithonian interval has suffered considerable decalcification and as a result good specimens of *M. perforata* are rare.

Dimensions. Io.6062, female carapace (Pl. 3, fig. 7), length 0·73 mm ; height 0·49 mm ; width 0·43 mm. Io.6063, male carapace (Pl. 3, fig. 3), length 0·78 mm ; height 0·49 mm ; width 0·44 mm. Io.6064, female carapace (Pl. 3, fig. 2), length 0·74 mm ; height 0·49 mm ; width 0·40 mm. Io.6065, male carapace (Pl. 3, fig. 1), length 0·84 mm ; height 0·56 mm ; width 0·47 mm.

Majungaella praeperforata sp. nov.

Pl. 3, figs 4–6, 8–10 ; Pl. 4, figs 1–3 ; Text-fig. 6

Diagnosis. Large species of *Majungaella* : male dimorphs 0·84–0·95 mm, female dimorphs 0·80–0·85 mm in length. Lateral surface coarsely ornamented by large pits forming rows extending down from the dorsal margin, diverging initially but turning inwards ventro-laterally.

Holotype. Io.6066, female carapace, sample B219 (Pl. 3, fig. 6).

Paratypes. Io.6067–74, sample B219.

Horizon and Locality. Middle or Upper Kimmeridgian, samples B219, B222 and B223, Mandawa Anticline (Text-fig. 3).

Description. **Carapace** dimorphic, thick-shelled and robust ; strongly convex in dorsal and ventral views. Ornamentation consisting of large pits forming rows diverging away from the dorsal margin but turning inwards ventro-laterally. Ventral surface with two distinct ridges on each valve. Left valve larger than right. **Hinge** entomodont, strongly developed. **Muscle scars** consisting of four rounded adductor scars with a large, rounded antero-dorsal frontal scar and an oval antero-ventral mandibular scar (Text-fig. 6 ; Pl. 3, fig. 9). **Duplicature** (calcified inner lamella) of moderate width with 18–19 straight to slightly curved anterior **marginal pore canals** (Pl. 3, fig. 10). Inner margin and line of concrescence coincide.

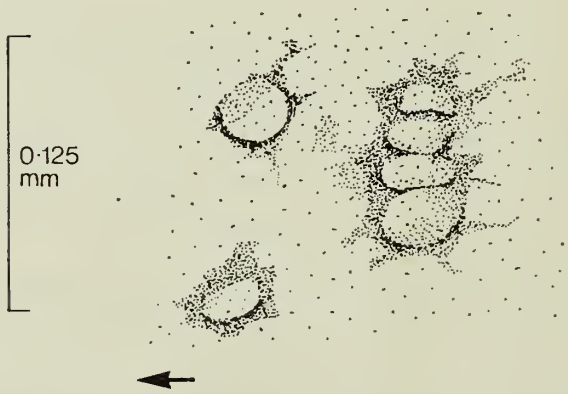

Fig. 6. *Majungaella praeperforata* sp. nov. Muscle scars, female right valve, paratype Io.6070.

Dimensions. Holotype, Io.6066, female carapace (Pl. 3, fig. 6), length 0·85 mm ; height 0·60 mm ; width 0·53 mm. Paratypes : Io.6067, female left valve (Pl. 3, fig. 4), length 0·81 mm ; height 0·57 mm. Io.6068, male left valve (Pl. 3, fig. 5), length 0·95 mm ; height 0·61 mm. Io.6069, male right valve (Pl. 3, fig. 10), length 0·84 mm ; height 0·45 mm. Io.6070, female right valve (Pl. 3, fig. 9 ; Text-fig. 6), length 0·80 mm ; height 0·53 mm. Io.6071, female carapace (Pl. 4, fig. 2), length

0·85 mm ; height 0·60 mm ; width 0·54 mm. Io.6072, female left valve (Pl. 3, fig. 8), length 0·78 mm ; height 0·66 mm. Io.6073, male right valve (Pl. 4, fig. 1), length 0·95 mm ; height 0·55 mm. Io.6074, female carapace (Pl. 4, fig. 3), length 0·60 mm ; height 0·52 mm.

Discussion. *Majungaella praeperforata* sp. nov. closely resembles the Upper Kimmeridgian *M. perforata* Grekoff but differs in size (*M. perforata* from Madagascar, length 0·69–0·80 mm ; from Tanzania, length female 0·74–0·78 mm, male 0·84 mm), the females ranging from 0·80 to 0·85 mm and the males up to 0·95 mm. *M. praeperforata* is also more robust in dorsal view, being very much more rotund in outline (cf. Pl. 3, fig. 7 and Pl. 4, figs 2, 3). There is also a slight difference in ornamentation between these two species : in *M. praeperforata* the pits are arranged in rows initially diverging from the dorsal margin whereas in *M. perforata* this development of rows does not exist in the dorsal and dorso-median region, the pits being more haphazard in their arrangement. In both there is a tendency to form rows in the ventro-lateral region.

M. praeperforata sp. nov. and *M. perforata* Grekoff possess a strongly pitted shell surface that differs from the ornamentation pattern of ridges and pits present in the younger *M. nematis* Grekoff 1963.

Majungaella kimmeridgiana sp. nov.

Pl. 4, figs 4–11 ; Pl. 5, figs 1–3 ; Text-fig. 7a–c

Diagnosis. *Majungaella* with subtrigonal lateral outline in female dimorph ; male subrectangular. Males 0·75–0·77 mm, females 0·64–0·69 mm in length. Shell surface coarsely pitted : pits arranged either in rows extending down from dorsal margin or irregularly spaced over carapace.

Holotype. Io.6075, female carapace, sample B103a (Pl. 4, fig. 4).

Paratypes. Io.6076–86, samples B103a and B104a.

Horizon and Locality. Lower Kimmeridgian, samples B103a, B104a and B106a, Mandawa Anticline (Text-fig. 3).

Description. **Carapace** dimorphic with left valve larger than the right, outline of shell as illustrated. Ornamentation as illustrated : ventral ribbing not well developed in anterior part of carapace. **Hinge** entomodont, robust and well developed. **Muscle scars** an oblique row of four, oval to rounded, with a rounded antero-dorsal frontal scar and a rounded antero-ventral mandibular scar (Text-fig. 7c). **Duplicature** broad ; inner margin and line of concrescence coinciding. **Marginal pore canals** slightly curved ; anteriorly 15–19 in number (one branching in Text-fig. 7b) and with the curve of the canals exaggerated by the internal convexity of the valve. Posteriorly there are five marginal canals some having a bulbous development at their mid-length.

Dimensions. Holotype, Io.6075, female carapace (Pl. 4, fig. 4), length 0·68 mm ; height 0·48 mm ; width 0·43 mm. Paratypes : Io.6076, male carapace (Pl. 5, fig. 1), length 0·77 mm ; height 0·47 mm ; width 0·47 mm. Io.6077, female left

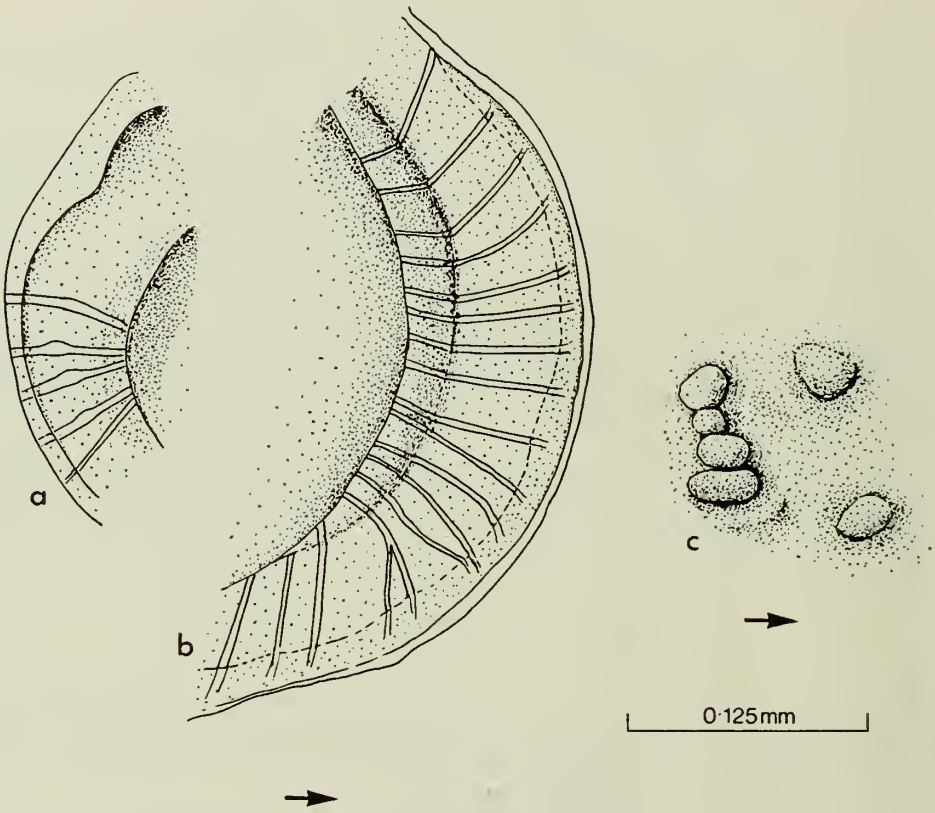

Fig. 7a–c. *Majungaella kimmeridgiana* sp. nov. a, b. Posterior and anterior marginal pore canals, female left valve, paratype Io.6087. c. Muscle scars, female left valve, paratype Io.6079.

valve (Pl. 4, fig. 9), length 0·69 mm ; height 0·47 mm. Io.6078, female right valve (Pl. 4, fig. 11), length 0·65 mm ; height 0·43 mm. Io.6080, female left valve (Pl. 4, fig. 8), length 0·68 mm ; height 0·47 mm. Io.6081, male carapace (Pl. 4, fig. 7), length 0·77 mm ; height 0·49 mm ; width 0·45 mm. Io.6082, male carapace (Pl. 5, fig. 3), length 0·76 mm ; height 0·47 mm ; width 0·43 mm. Io.6083, male left valve (Pl. 5, fig. 2), length 0·75 mm ; height 0·47 mm. Io.6084, female carapace (Pl. 4, fig. 6), length 0·66 mm ; height 0·47 mm ; width 0·42 mm. Io.6085, female carapace (Pl. 4, fig. 5), length 0·64 mm ; height 0·44 mm ; width 0·41 mm. Io.6086, female carapace (Pl. 4, fig. 10), length 0·69 mm ; height 0·47 mm ; width 0·43 mm.

Discussion. *Majungaella kimmeridgiana* sp. nov. is smaller than *M. praeperforata* sp. nov. and *M. perforata* Grekoff and, in the female, rather more subtrigonal in outline. The ornamentation is closely comparable in some individuals but differs markedly in those where the pits are not arranged in rows (Pl. 4, fig. 5 and

Pl. 5, fig. 2). The ventral ribbing of *M. kimmeridgiana* is less distinctly developed than in *M. praeperforata* and the marginal pore canals are more distinctly curved.

Majungaella oxfordiana sp. nov.

Pl. 5, figs 4–9

Diagnosis. *Majungaella* with weak surface ornamentation of pits. Carapace distinctly tapered to narrow posterior end.

Holotype. Io.6088, female carapace, sample B2 (Pl. 5, fig. 5).

Paratypes. Io.6089–94, sample B2.

Horizon and Locality. Upper Oxfordian, samples B2 and B67, Wami River Area (Text-fig. 2).

Description. **Carapace** with strong posterior taper, dimorphic ; males very elongate with a more marked posterior taper than in the females. Left valve larger than the right. Ornamentation weak ; pits appear to be irregularly scattered over the shell surface although linearly arranged in the ventro-lateral region. **Hinge** entomodont, robust. **Muscle** scars not seen. **Duplicature** of moderate width with approximately 16 slightly curved anterior marginal pore canals.

Dimensions. Holotype, Io.6088, female carapace (Pl. 5, fig. 5), length 0·72 mm ; height 0·51 mm ; width 0·43 mm. Paratypes : Io.6089, male carapace (Pl. 5, fig. 4), length 0·77 mm ; height 0·44 mm ; width 0·38 mm. Io.6090, female left valve (Pl. 5, fig. 8), length 0·68 mm ; height 0·46 mm. Io.6091, female right valve (Pl. 5, fig. 9), length 0·70 mm ; height 0·44 mm. Io.6092, female left valve (Pl. 5, fig. 7), length 0·72 mm ; height 0·48 mm. Io.6093, female carapace (Pl. 5, fig. 6), length 0·69 mm ; height 0·47 mm ; width 0·40 mm.

Discussion. *Majungaella oxfordiana* sp. nov. is the same size as *M. kimmeridgiana* sp. nov. but is not so positively ornamented and differs in carapace outline. The extremely strong posterior taper present in the male of *M. oxfordiana* makes it almost identical to the male of *Progonocythere laeviscula* Ljubimova & Mohan 1960, although it lacks the diagnostic crescent-shaped median sulcus of the latter.

The material available of *M. oxfordiana* is very poorly preserved and tends to be encrusted by quartz grains. As a result the determination of the surface ornamentation is not always possible and many specimens appear to be smooth.

Majungaella mundula (Grekoff)

Pl. 5, figs 10–13

1963 *Progonocythere mundula* Grekoff : 1738, pl. 4, figs 92–95.

Material. Seven specimens, Io.6095–101, samples B66 and B97.

Horizon and Locality. Middle Callovian, sample B66, Wami River Area (Text-fig. 2) and sample B97, Mandawa Anticline (Text-fig. 3).

Discussion. Grekoff (1963) described a new ostracod of the genus *Progonocythere* from the Middle Callovian of Madagascar. This species, *P. mundula*, is small

(length 0·43–0·50 mm), has a strongly pitted shell surface and apparently lacks sexual dimorphism. Guha (1975?) records this species from the Bathonian/Callovian interval of Kutch and it is recorded here from the Middle Callovian of Tanzania. The Tanzanian specimens are slightly larger than those recorded from Madagascar and have a length of 0·53–0·55 mm. No measurements are available for the Indian material.

Of the species from Madagascar assigned to *Progonocythere* by Grekoff, only *Progonocythere laeviscula* Ljubimova & Mohan 1960 is considered truly to represent that genus south of the Tethys. *P. mundula* is considered to belong more correctly to the genus *Majungaella* of which it is currently the oldest known species.

Dimensions. Io.6095, carapace (Pl. 5, fig. 12), length 0·49 mm ; height 0·35 mm ; width 0·29 mm. Io.6096, carapace (Pl. 5, fig. 10), length 0·49 mm ; height 0·36 mm ; width 0·30 mm. Io.6097, carapace (Pl. 5, fig. 13), length 0·55 mm ; height 0·39 mm ; width 0·32 mm. Io.6098, carapace (Pl. 5, fig. 11), length 0·53 mm ; height 0·37 mm ; width 0·37 mm.

Genus ***FASTIGATOCYTHERE*** Wienholz 1967

Fastigatocythere is retained here as a distinct genus despite the fact that Dépêche (1973) relegated it to the position of a subgenus of *Lophocythere*, almost certainly because Wienholz included *Lophocythere interrupta* Triebel 1951 in *Fastigatocythere*. However, the type species of *Fastigatocythere*, *F. rugosa* Wienholz 1967, does not appear to be congeneric with *L. interrupta* and the two species are considered to belong to separate genera.

In addition to *F. rugosa* and *Progonocythere juglandica* (Jones 1884), Wienholz included the following Madagascar species of Grekoff 1963 in her genus : *Progonocythere accesa*, *P. bicruciata*, *P. befotakaensis*, *P.* 2392 and the subspecies *P. juglandica malgachica*. This effectively removed the majority of the southern species assigned to *Progonocythere* from that genus ; of the remainder only *Progonocythere laeviscula* Ljubimova & Mohan is considered to represent *Progonocythere* satisfactorily south of the Tethys.

Fastigatocythere aff. ***brentonensis*** (Dingle 1972)

Pl. 6, figs 9, 10 ; Pl. 7, fig. 9

Material. Three specimens, Io.6102–4, sample B223.

Horizon and Locality. Middle or Upper Kimmeridgian, samples B219 and B223, Mandawa Anticline (Text-fig. 3).

Discussion. Of the three left valves assigned to this species only one (Io.6102) possesses obliquely transverse ridges and thus more closely resembles *F. brentonensis* (Dingle), but it is less positively ornamented, lacking the surface reticulation illustrated by Dingle. All three specimens are smaller than Dingle's material and could represent juvenile instars. In the absence of further material it is not possible to do more than draw attention to its affinities with the South African ostracod.

Dimensions. Io.6102, left valve (Pl. 6, fig. 9), length 0·43 mm ; height 0·26 mm. Io.6104, left valve (Pl. 6, fig. 10), length 0·37 mm ; height 0·22 mm.

Genus *TRICHORDIS* Grekoff 1963

Trichordis triangula sp. nov.

Pl. 6, figs 1–8, 14 ; Text-fig. 8a, b

Diagnosis. Species of *Trichordis* with distinct posterior taper and triangular lateral outline. Three prominent lateral ribs ; ventral surface deeply pitted with three ridges on each valve.

Holotype. Io.6105, female carapace, sample B219 (Pl. 6, figs 1, 5).

Paratypes. Io.6106–12 ; samples B107a, B219 and BM86.

Horizon and Locality. Upper Oxfordian ; samples BM86 and B68, Wami River Area (Text-fig. 2) and Lower and Middle or Upper Kimmeridgian ; samples B107a, B219 and B223, Mandawa Anticline (Text-fig. 3).

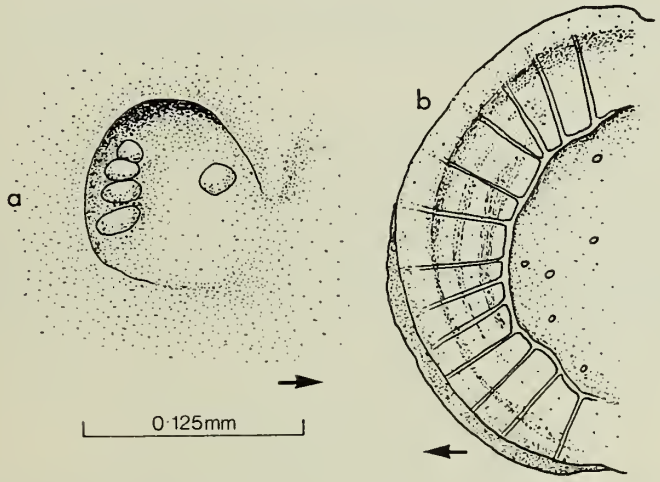

Fig. 8a, b. *Trichordis triangula* sp. nov. a. Muscle scars, female left valve, paratype Io.6110. b. Anterior marginal pore canals, male right valve, paratype Io.6112.

Description. **Carapace** dimorphic although the presumed males are only slightly more elongate than the females. Left valve larger than the right. Ornamentation rather insignificant, consisting of weak pits superimposed upon the structural ribs. **Hinge** entomodont, rather strongly developed. **Duplicature** broad anteriorly and, apart from a narrow anterior zone into which run the 12–14 straight **marginal pore canals** (Text-fig. 8b), the inner margin coincides with the line of concrescence. **Selvage** prominent, anterior **flange** distinct. **Muscle scars**

consist of four oval adductor scars and a rounded frontal scar (Text-fig. 8a) internally set in a deep muscle scar pit, reflected on the outside of the valve by a broad swelling.

Dimensions. Holotype, Io.6105, female carapace (Pl. 6, figs 1, 5), length 0·50 mm ; height 0·32 mm ; width 0·26 mm. Paratypes : Io.6106, female left valve (Pl. 6, fig. 7), length 0·43 mm ; height 0·29 mm. Io.6107, male left valve (Pl. 6, fig. 4), length 0·42 mm ; height 0·23 mm. Io.6108, female carapace (Pl. 6, fig. 6), length 0·51 mm ; height 0·31 mm ; width 0·26 mm. Io.6109, female left valve (Pl. 6, fig. 3), length 0·49 mm ; height 0·32 mm. Io.6110, female left valve (Pl. 6, fig. 8 ; Text-fig. 8a), length 0·51 mm ; height 0·33 mm. Io.6111, male right valve (Pl. 6, fig. 14), length 0·50 mm ; height 0·27 mm.

Discussion. *Trichordis triangula* sp. nov. differs from *T. praetexta* Grekoff 1963 in having the three lateral ridges of the genus more prominently developed and having a more triangular outline in lateral view. The hinge of *T. triangula* is entomodont and thus differs from the modified entomodont hinge of *T. praetexta* in which the median element, apart from the two antero-median teeth, appears to be smooth. There is also an increased number of anterior marginal pore canals which, being straight and simple, lack the median swelling of those present in *T. praetexta*. Despite all the differences that go beyond ordinary specific characters it is considered that this Tanzanian species belongs to *Trichordis*, although it may be necessary later to subdivide the genus.

Genus *MANDELSTAMIA* Ljubimova 1955

The genus *Mandelstamia* was placed in the family Cytheridae by Orlov (1960), whereas Moore (1961) grouped it with others under an uncertain family heading. Here *Mandelstamia* is considered to belong in the Progonocytherinae, having in common with the other genera grouped here the general carapace outline, straight or only slightly curved rather simple marginal pore canals and muscle scar pattern.

Mandelstamia grekoffi sp. nov.

Pl. 7, figs 1–6

Diagnosis. *Mandelstamia* with subrectangular carapace tapering to narrowly rounded posterior end. Shell surface with neat reticulate ornamentation.

Holotype. Io.6172, right valve, sample B219 (Pl. 7, fig. 4).

Paratypes. Io.6168–71, samples B219 and B223.

Horizon and Locality. Middle or Upper Kimmeridgian, samples B219 and B223, Mandawa Anticline (Text-fig. 3).

Description. **Carapace** outline and ornamentation as illustrated. Shallow median constriction of carapace visible in dorsal view. Ventro-lateral surface convex, partially overhanging ventral surface. **Hinge** lophodont. **Muscle scars** not observed. **Duplicature** very narrow, marginal pore canals not observed.

Dimensions. Holotype, Io.6172, right valve (Pl. 7, fig. 4), length 0·50 mm, height 0·26 mm. arpes : PatyIo.6168, left valve (Pl. 7, fig. 3), length 0·46 mm, height 0·25 mm. Io.6169, carapace (Pl. 7, fig. 2), length 0·57 mm ; height 0·30 mm ; width 0·23 mm. Io.6170, right valve (Pl. 7, figs 5, 6), length 0·64 mm ; height 0·30 mm. Io.6171, carapace (Pl. 7, fig. 1), length 0·42 mm ; height 0·21 mm ; width 0·16 mm.

Discussion. In lateral view *Mandelstamia grekoffi* sp. nov. closely resembles *Mandelstamia* ? 962 of Grekoff (1963), from the Valanginian of Madagascar. The two species are more readily distinguished in dorsal view by the absence of a median constriction and a much thicker carapace in *M.* ? 962. *Mandelstamia angulata* Kilenyi 1961, from the Lower Kimmeridgian of England, is a comparable species but although showing the median constriction is much more robust in dorsal view and not so slender in lateral outline.

Mandelstamia sp.

Pl. 7, figs 7, 8

Material. Three specimens, Io.6165–7, samples B219 and B223.

Horizon and Locality. Middle or Upper Kimmeridgian, samples B219 and B223, Mandawa Anticline (Text-fig. 3).

Discussion. *Mandelstamia* sp. is a new species represented by only three specimens. It is close to *Mandelstamia* ? 962 of Grekoff (1963), but differs by being smaller and in ornament by having larger pits between which the shell surface is upraised to form low ridges. Apart from the lophodont hinge and narrow duplicature the internal details have not been observed.

Dimensions. Io.6165, right valve (Pl. 7, fig. 8), length 0·43 mm ; height 0·23 mm. Io.6166, carapace (Pl. 7, fig. 7), length 0·47 mm ; height 0·25 mm ; width 0·19 mm.

Subfamily **PLEUROCYTHERINAE** Mandelstam 1960

Genus ***PLEUROCYTHERE*** Triebel 1951

Pleurocythere tanzanensis sp. nov.

Pl. 6, figs 11–13 ; Text-fig. 9a, b

Diagnosis. *Pleurocythere* with dorsal carina fusing anteriorly with eye node, posteriorly with median and ventral carinae. Shell surface reticulate. Hinge of antimerodont/amphidont type. Marginal pore canals straight, few in number.

Holotype. Io.6137, carapace, sample B223 (Pl. 6, figs 11, 12).

Paratypes. Io.6138–9, sample B223.

Horizon and Locality. Middle or Upper Kimmeridgian, sample B223, Mandawa Anticline (Text-fig. 3).

Description. **Carapace** and ornamentation as illustrated. The **eye node** is here more clearly visible in the left valve. Left valve larger than the right. **Hinge**

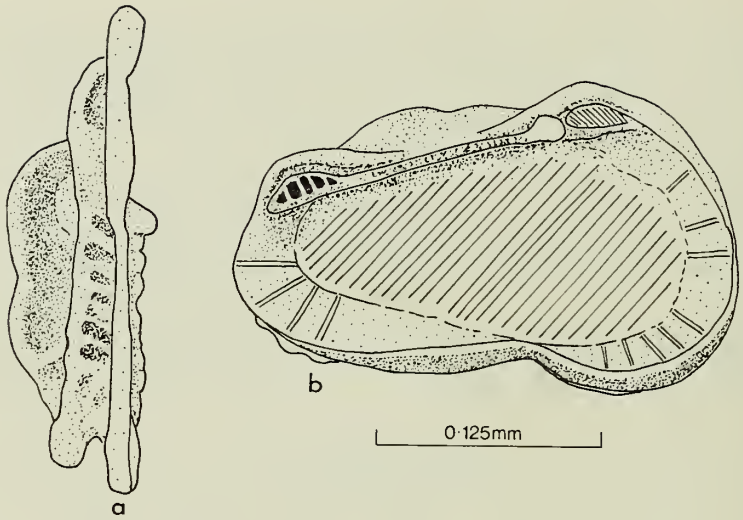

Fig. 9a, b. *Pleurocythere tanzanensis* sp. nov. Dorsal and internal views, left valve, paratype Io.6139.

of antimerodont/amphidont type, only seen in the left valve (Text-fig. 9a) where all the elements are dentate/loculate ; median element possesses a single large antero-median tooth. **Duplicature** moderately broad with few widely spaced, straight, anterior **marginal pore canals. Muscle scars** not seen.

Dimensions. Holotype, Io.6137, carapace (Pl. 6, figs 11, 12), length 0·45 mm ; height 0·22 mm ; width 0·21 mm. Paratype Io.6138 (Pl. 6, fig. 13), length 0·49 mm ; height not measurable (broken).

Discussion. *Pleurocythere tanzanensis* sp. nov. is placed in *Pleurocythere* on the external morphology of the carapace. There are, however, differences which set this species apart from European species. The hinge of *P. tanzanensis* differs from the normal antimerodont type in having an enlarged antero-median tooth, the hinge thereby approaching the amphidont condition. The anterior marginal pore canals are straight rather than curved as in other species and the dorsal carina fuses with the eye node. These differences are sufficient to suggest a subgeneric rank for *P. tanzanensis* but a decision on this is deferred until other southern hemisphere species have been described.

Family **SCHULERIDEIDAE** Mandelstam 1959

Genus ***AMICYTHERIDEA*** nov.

Derivation of Name. *Ami+cytheridea*, *Ami* being derived from the initial letters A.M.I. of Africa, Madagascar and India, countries in which this genus is known to occur. Gender, feminine.

DIAGNOSIS. Carapace robust, triangular in lateral outline, convex in dorsal view, dimorphic. Left valve larger than right. Sculpture of ridges arranged in triangular pattern with apex at dorsal margin. Distinct marginal borders ; oblique antero-dorsal furrow. Hinge lobodont. Duplicature broad without vestibule. Marginal pore canals anteriorly approximately 14 in number, straight but slightly curved antero-ventrally. Muscle scars a curved row of four adductors with an antero-central frontal scar.

TYPE SPECIES. *Amicytheridea ihopyensis* (Grekoff 1963).

DISCUSSION. Two species are assigned to this genus, *A. triangulata* sp. nov. from the Middle Callovian of the Mandawa Anticline (= *Procytheridea* 3330 of Grekoff (1963) from the Callovian of Madagascar), and *A. ihopyensis* (Grekoff) from the Middle Callovian of the Wami River Area, from the Bathonian/Callovian of Madagascar (Grekoff 1963) and from the Bathonian/Callovian of Kutch (Guha 1975?).

Amicytheridea is similar in ornament to the European Lower to Middle Jurassic ostracod *Ektyphocythere* Bate (1963a), but differs in having a lobodont hinge and a more positive posterior taper to the carapace. Perhaps externally more closely similar to the European Lower and Middle Jurassic ostracod *Eocytheridea* Bate (1963b), it differs internally in details of the hinge and marginal pore canals. However, *Amicytheridea* might well be shown to be phylogenetically related to *Eocytheridea*, and it is quite possible that it developed from the latter, or a common ancestor, and migrated south.

Amicytheridea ihopyensis (Grekoff 1963)

Pl. 7, figs 10–13 ; Text-fig. 10a–c

1963 *Procytheridea ihopyensis* Grekoff : 1747, pl. 6, figs 164–172, pl. 10, fig. 237.

MATERIAL. Six specimens, Io.6116–21, samples B97 and BM94.

HORIZON AND LOCALITY. Middle Callovian, sample BM94, Wami River Area (Text-fig. 2) and samples B97 and B114, Mandawa Anticline (Text-fig. 3).

DISCUSSION. Grekoff records this species from the Lower Callovian and rarely from the Upper Bathonian of Madagascar. This range is also reported by Guha from India (1975?). The total known range is therefore from the Upper Bathonian to Middle Callovian with a geographical distribution of India, East Africa and Madagascar.

Amicytheridea ihopyensis (Grekoff) is the type species of the genus and exhibits the morphological features of the family, namely a large antero-central frontal scar, anterior marginal pore canals splayed out and showing a tendency to be curved, and a rather thick-shelled, robust carapace.

DIMENSIONS. Io.6251, female carapace (Pl. 7, fig. 11), length 0·59 mm ; height 0·37 mm ; width 0·33 mm. Io.6117, female left valve (Pl. 7, fig. 10), length 0·55 mm ; height 0·35 mm. Io.6118, juvenile carapace (Pl. 7, fig. 12), length 0·44 mm ; height 0·29 mm ; width 0·29 mm. Io.6119, female carapace (Pl. 7,

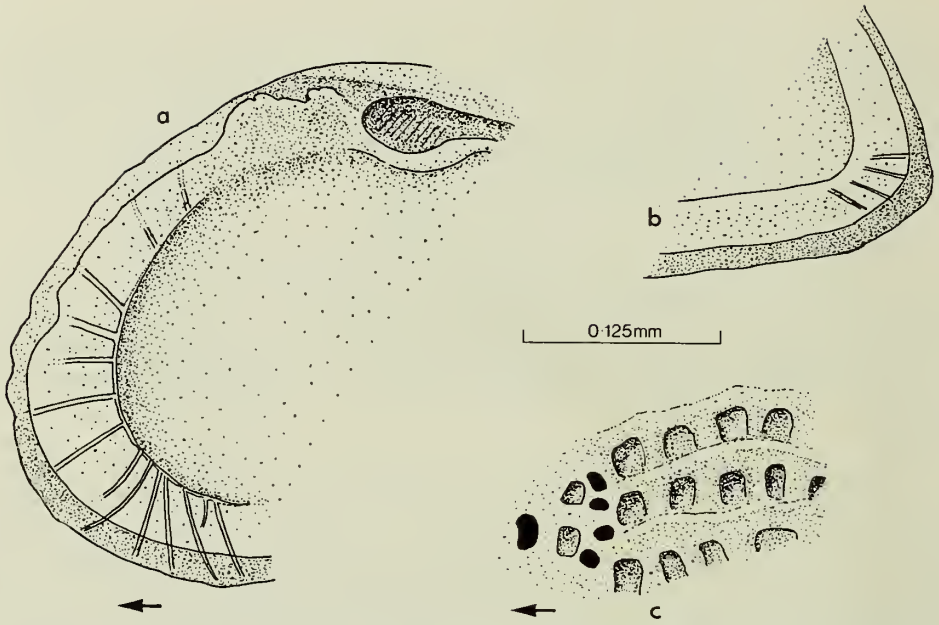

FIG. 10a–c. *Amicytheridea ihopyensis* (Grekoff). a, b. Anterior and posterior duplicature, female right valve, to show marginal pore canals, Io.6120. c. Muscle scars, male left valve exterior, Io.6121.

fig. 13), length 0·52 mm ; height 0·34 mm ; width 0·38 mm. Io.6121, male left valve (Text-fig. 10c), length 0·62 mm ; height 0·33 mm.

Amicytheridea triangulata sp. nov.

Pl. 7, figs 14–16 ; Text-fig. 11a–c

1963 *Procytheridea* ? 3330 Grekoff : 1749, pl. 6, figs 173–5.

DIAGNOSIS. *Amicytheridea* with positive triangular ornamentation of ridges connected across interspaces by minor ridges.

HOLOTYPE. Io.6114, female left valve, sample B97 (Pl. 7, fig. 16).

PARATYPES. Io.6113 and Io.6115–6, sample B97.

HORIZON AND LOCALITY. Middle Callovian, sample B97, Mandawa Anticline (Text-fig. 3).

DESCRIPTION. **Carapace** distinctly dimorphic, males very positively tapering to posterior end. Left valve larger than right. **Ornamentation** striking – a triangular arrangement of ridges with minor connecting ridges. Anterior marginal border distinct. Oblique antero-dorsal furrow clearly marked ; postero-dorsal furrow present in female. **Hinge** lobodont, antero-median element loculate in right valve (Text-fig. 11a). **Duplicature** broad, without a vestibule. **Marginal pore canals** not clearly seen but in one specimen (Text-fig. 11b) straight, splayed out and few in number (8 observed anteriorly). **Muscle scars** not seen.

Dimensions. Holotype, Io.6114, female left valve (Pl. 7, fig. 16; Text-fig. 11b, c) length 0·60 mm; height 0·37 mm. Paratypes: Io.6113, male carapace (Pl. 7, figs 14, 15), length 0·65 mm; height 0·36 mm; width 0·35 mm.

Discussion. *Amicytheridea triangulata* sp. nov. is considered to be synonymous with *Procytheridea* ? 3330 described by Grekoff (1963), from the Upper Callovian of Madagascar. Although the muscle scars have not been seen and the marginal pore canals only poorly so the species is still regarded as belonging to *Amicytheridea*. The lobodont hinge of *A. triangulata* is particularly well seen in this material, which may be distinguished from *A. ihopyensis* by the more positively developed ornamentation. Indeed the carapace outline and ornamentation make *A. triangulata* closely comparable with the European Bajocian ostracod *Eocytheridea carinata* Bate 1964, although the cross ridges and lobodont hinge of *A. triangulata* serve to distinguish the two.

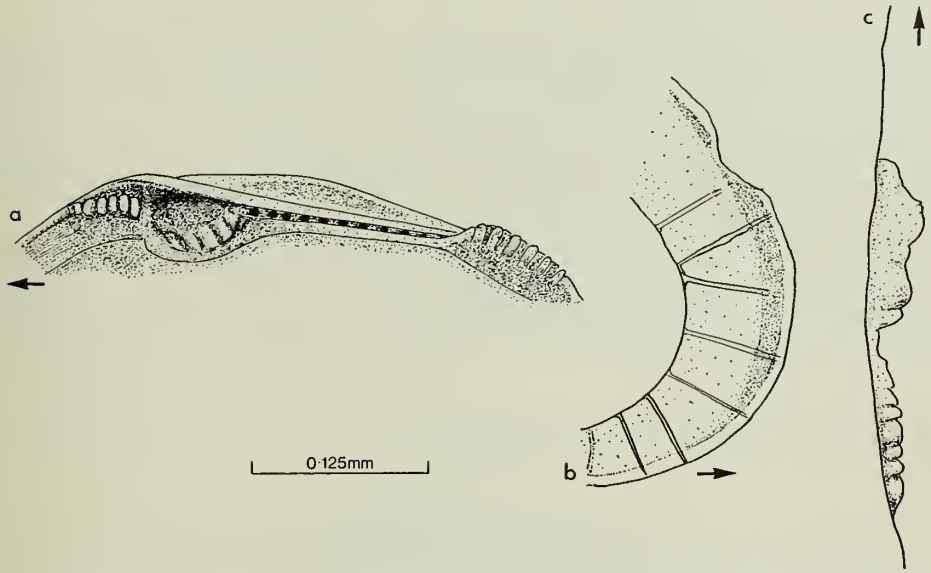

Fig. 11a–c. *Amicytheridea triangulata* sp. nov. a. Right valve hinge, female, paratype Io.6115. b, c. Anterior marginal pore canals and dorsal view of median hinge element, female left valve, holotype Io.6114.

Genus ***ASCIOCYTHERE*** Swain 1952

Asciocythere ? sp.

Pl. 8, figs 1, 2

Material. Two specimens, Io.6252–3, sample B114.

Horizon and Locality. Middle Callovian, sample B114, Mandawa Anticline (Text-fig. 3).

Discussion. Two complete carapaces of a small ostracod are placed here in *Asciocythere* purely on external morphology. No internal details known.

Dimensions. Io.6252, carapace (Pl. 8, fig. 2), length 0·35 mm ; height 0·24 mm ; width 0·19 mm. Io.6253, carapace (Pl. 8, fig. 1), length 0·37 mm ; height 0·26 mm ; width 0·20 mm.

Genus ***PIRILEBERIS*** Grekoff 1963

Pirileberis prognata Grekoff 1963

Pl. 8, figs 9–11

1963 *Pirileberis prognata* Grekoff : 1750, pl. 6, figs 156–161.

Material. Nine specimens, Io.6151–7 and Io.6163–4, samples B66, B110 and B111.

Horizon and Locality. Middle Callovian, sample B66, Wami River Area (Text- fig. 2) and Upper Tithonian, samples B110 and B111, Mandawa Anticline (Text-fig. 3).

Discussion. Grekoff (1963) records *Pirileberis prognata* from the Kimmeridgian and Portlandian of Madagascar while Guha (1975?) records it from the Callovian to Kimmeridgian of Kutch (India). Here, *P. prognata* has been found in both Middle Callovian and Upper Tithonian sediments.

Dimensions. Io.6154, male carapace (Pl. 8, fig. 10), length 0·71 mm ; height 0·43 mm ; width 0·30 mm. Io.6163, male carapace (Pl. 8, fig. 11), length 0·66 mm ; height 0·35 mm ; width 0·29 mm. Io.6164, female carapace (Pl. 8, fig. 9), length 0·66 mm ; height 0·42 mm ; width 0·29 mm.

Pirileberis ? sp.

Pl. 8, figs 3–6

Material. Five specimens, Io.6158–62, samples B110 and B111.

Horizon and Locality. Upper Tithonian, samples B110 and B111, Mandawa Anticline (Text-fig. 3).

Discussion. This new species is a rare member of the Upper Tithonian fauna which on general carapace morphology and presence of an antimerodont hinge appears to belong to *Pirileberis*. The generic assignment is queried because of the lack of information concerning the muscle scars and anterior marginal pore canals. Unlike *Pirileberis prognata* this species does not appear to be dimorphic and is also much more squat in side view.

Dimensions. Io.6158, carapace (Pl. 8, fig. 6), length 0·53 mm ; height 0·38 mm ; width 0·26 mm. Io.6159, left valve (Pl. 8, fig. 4), length 0·49 mm ; height 0·37 mm. Io.6160, carapace (Pl. 8, fig. 5), length 0·55 mm ; height 0·37 mm ; width 0·21 mm. Io.6162, carapace (Pl. 8, fig. 3), length 0·55 mm ; height 0·39 mm ; width 0·25 mm.

Family **CYTHERIDEIDAE** Sars 1925
Subfamily **CYTHERIDEINAE** Sars 1925
Genus ***AFROCYTHERIDEA*** nov.

Diagnosis. Carapace thick-shelled, dimorphic, subrectangular, posteriorly tapering. Dorsal margin sinuous. Conspicuous antero-dorsal furrow below convex, projecting, anterior cardinal angle. Shell surface smooth or reticulate. Left valve larger than right. Normal pore canals large, widely spaced. Anterior marginal pore canals curved, approximately 14 in number. Hinge lobodont. Duplicature of moderate width ; no vestibule.

Type Species. *Afrocytheridea laevigata* sp. nov.

Discussion. *Afrocytheridea* gen. nov. (gender feminine) externally resembles the Bajocian/Bathonian ostracod *Eocytheridea* Bate 1964, but differs in the possession of a lobodont hinge. The anterior marginal pore canals are curved in both genera but the absence of details relating to the muscle scars of *Afrocytheridea* prevents a close phylogenetic comparison. At the present time *Afrocytheridea* is placed in the Cytherideinae rather than with *Eocytheridea* in the Schulerideidae, although it may be necessary to reassign it when details of the muscle scars become known.

Two species are assigned here to *Afrocytheridea*, *A. laevigata* sp. nov. and *A. faveolata* sp. nov., both from the Middle Callovian.

Afrocytheridea laevigata sp. nov.

Pl. 8, fig. 14 ; Pl. 9, figs 1–4 ; Text-fig. 12

Diagnosis. *Afrocytheridea* without surface ornamentation.

Holotype. Io.6122, female carapace, sample B66 (Pl. 9, fig. 3).

Paratypes. Io.6123–7, sample B66.

Horizon and Locality. Middle Callovian, sample B66, Wami River Area (Text-fig. 2).

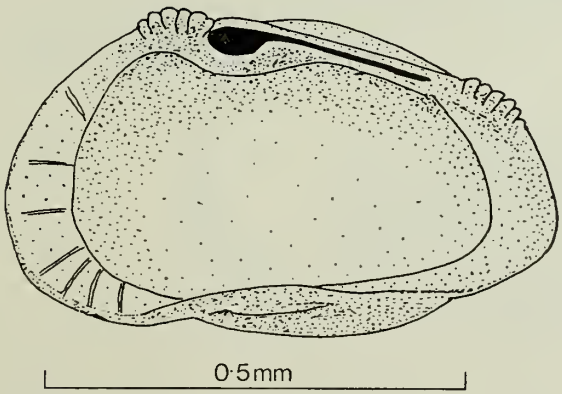

Fig. 12. *Afrocytheridea laevigata* sp. nov. Internal view, right valve, paratype Io.6126.

Description. **Carapace** outline as illustrated and showing marked sexual dimorphism. The absence of ornamentation emphasizes the deep antero-dorsal furrow and the simple normal pore canal openings. **Hinge** lobodont (Text-fig. 12), although details of the median element are obscured owing to the state of preservation. **Duplicature** of moderate width without a vestibule and with straight to slightly curved anterior **marginal pore canals** which are few in number and widely spaced. **Muscle scars** not seen.

Dimensions. Holotype. Io.6122, female carapace (Pl. 9, fig. 3), length 0·82 mm ; height 0·47 mm ; width 0·45 mm. Paratypes : Io.6123, female carapace (Pl. 9, fig. 1), length 0·76 mm ; height 0·44 mm ; width 0·44 mm. Io.6124, male carapace (Pl. 9, fig. 2), length 0·88 mm ; height 0·46 mm ; width 0·42 mm. Io.6125, male carapace (Pl. 8, fig. 14), length 0·88 mm ; height 0·48 mm ; width 0·43 mm. Io.6127, female carapace (Pl. 9, fig. 4), length 0·77 mm ; height 0·43 mm ; width 0·43 mm.

Discussion. This is a distinctive species superficially resembling the ostracod *Fabanella bathonica* (Oertli 1957) from the Bathonian of Europe, but it differs totally in internal details and externally in the presence of an antero-dorsal furrow.

Afrocytheridea faveolata sp. nov.

Pl. 8, figs 12, 13 ; Text-fig. 13a–d

Diagnosis. *Afrocytheridea* with distinct reticulate ornamentation.

Holotype. Io.6132, female right valve, sample B97 (Pl. 8, fig. 12).

Paratypes. Io.6128–31 and Io.6133, sample B97.

Horizon and Locality. Middle Callovian, samples B97 and B114. Mandawa Anticline (Text-fig. 3).

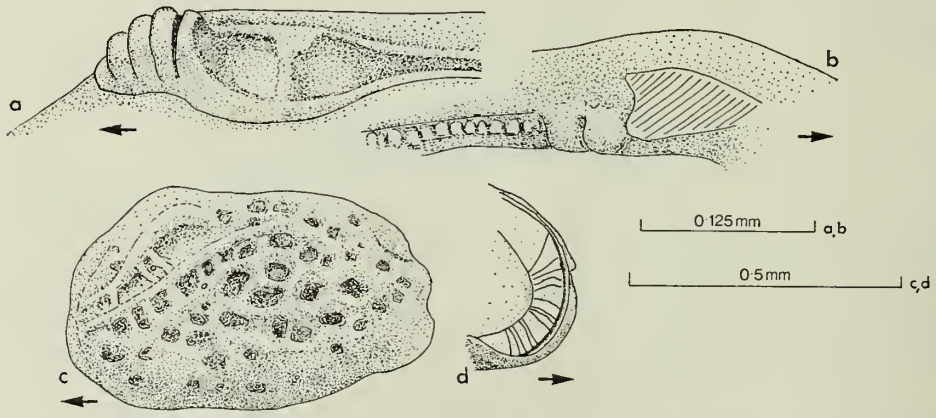

Fig. 13a–d. *Afrocytheridea faveolata* sp. nov. a. Anterior teeth and antero-median sockets, right valve hinge, paratype Io.6131. b. Anterior part of median hinge bar to show enlarged antero-median teeth, left valve, paratype Io.6133. c. External view, left valve, paratype Io.6129. d. Anterior marginal pore canals, left valve, paratype Io.6130.

Description. **Carapace** thick-shelled, distinctly ornamented by honeycomb-type reticulation. Spaces between reticulae upraised, forming ridges in antero-dorsal region. **Hinge** lobodont; median element denticulate with two antero-median teeth in the left valve (Text-fig. 13b), antero-median socket bifurcate (Text-fig. 13a). **Muscle scars** not seen. **Duplicature** of moderate width with some 14 curved anterior **marginal pore canals.** No vestibule.

Dimensions. Holotype, Io.6132, female right valve (Pl. 8, fig. 12), length 0·73 mm; height 0·40 mm. Paratypes, Io.6128, male right valve (Pl. 8, fig. 13), length 0·77 mm; height 0·38 mm. Io.6129, female left valve (Text-fig. 13c), length 0·73 mm; height 0·44 mm.

Subfamily **GALLIAECYTHERIDEINAE** Andreev & Mandelstam 1964

Genus ***GALLIAECYTHERIDEA*** Oertli 1957

Galliaecytheridea manyuliensis sp. nov.

Pl. 9, figs 5–14; Text-fig. 14a–c

Diagnosis. *Galliaecytheridea* with oval/elongate carapace tapering posteriorly with line of greatest length passing through or above mid-point. Shell surface finely pitted. Sexual dimorphism distinct. Hinge antimerodont. Curved anterior marginal pore canals, 17–19 in number.

Holotype. Io.6141, female right valve, sample B107a (Pl. 9, fig. 5).

Paratypes. Io.6142–50, sample 107a.

Horizon and Locality. Lower Kimmeridgian, samples B103a, B104a, B106a and B107a, Mandawa Anticline (Text-fig. 3).

Description. **Carapace** dimorphic, males very elongate, almost parallel-sided; females oval with sharp posterior taper. Left valve larger than right. Shell surface finely pitted. Anterior margin often with small denticles. **Hinge** antimerodont with a tendency for the antero-median teeth of the median element to increase in size (Pl. 9, figs 11–13). **Duplicature** of moderate width; the inner margin and line of concrescence coincide except antero-medially where a very narrow **vestibule** is developed (Text-fig. 14a) from which the marginal canals extend. Anterior **marginal pore canals** curved, 17–19 in number. **Muscle scars** consist of an oblique row of four round adductor scars, a large antero-dorsal frontal scar and an equally large antero-ventral mandibular scar (Pl. 9, fig. 14).

Dimensions. Holotype. Io.6141, female right valve (Pl. 9, fig. 5), length 0·66 mm; height 0·37 mm. Paratypes: Io.6142, female left valve (Pl. 9, fig. 12), length 0·67 mm; height 0·43 mm. Io.6143, female right valve (Pl. 9, figs 7, 13), length 0·66 mm; height 0·37 mm. Io.6144, female left valve (Pl. 9, fig. 10), length 0·61 mm; height 0·35 mm. Io.6145, male left valve (Pl. 9, figs 11, 14), length 0·77 mm; height 0·40 mm. Io.6146, male right valve (Pl. 9, fig. 9), length 0·78 mm; height 0·37 mm. Io.6147, female left valve (Pl. 9, fig. 8), length 0·64 mm; height 0·40 mm. Io.6148, male left valve (Pl. 9, fig. 6; Text-fig. 14a), length 0·80 mm; height 0·43 mm. Io.6149, female carapace (Text-fig. 14b, c), length 0·70 mm;

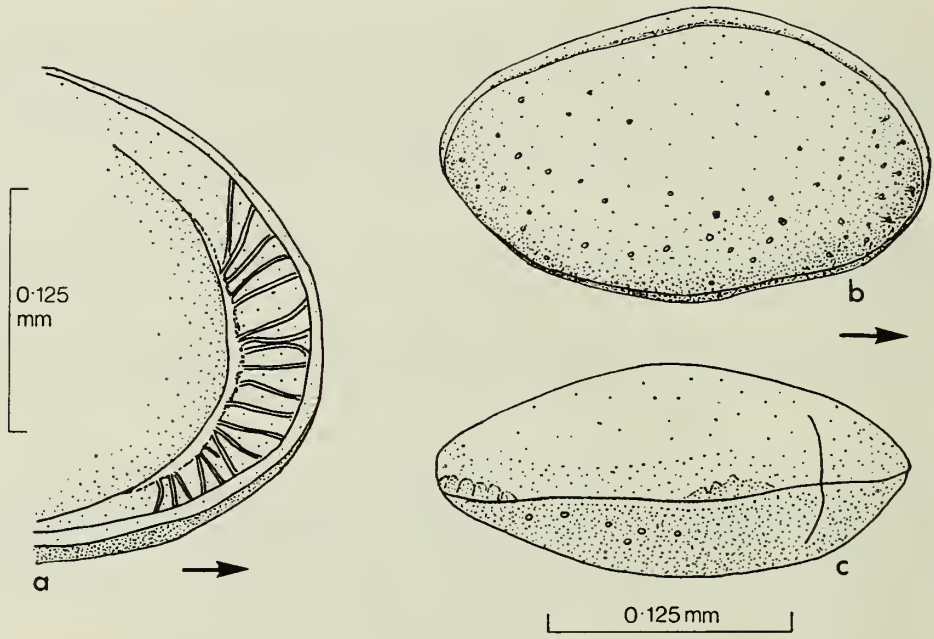

FIG. 14a–c. *Galliaecytheridea manyuliensis* sp. nov. a. Anterior duplicature and marginal pore canals, male left valve, paratype Io. 6148. b, c. Right and dorsal views, female carapace, paratype Io.6149.

height 0·43 mm ; width 0·24 mm. Io.6150, male carapace, length 0·78 mm ; height 0·42 mm ; width 0·33 mm.

DISCUSSION. *Galliaecytheridea* as diagnosed possesses a hemimerodont hinge, the median element being smooth. In *Galliaecytheridea manyuliensis* sp. nov., however, the hinge is antimerodont, the anteromedian element of which shows an increase in size of the teeth in the left valve and of the loculae in the right. Thus the hinge approaches the entomodont condition as described in *Galliaecytheridea* ? *kingscliffensis* Bate 1967, from the Bathonian of England. *G. manyuliensis* in common with *G.* ? *kingscliffensis* thus possesses a hinge differing from that described in all other species of *Galliaecytheridea*, although both species have the other morphological characters of the genus. The introduction of a subgeneric unit at this stage does not, however, appear to be necessary.

The lateral outline of the female dimorph is generally most useful in distinguishing between species of *Galliaecytheridea* and in this respect *G. manyuliensis* is easily separated from the more squat and robust *G.* ? *kingscliffensis*. *G. remota* Grekoff 1963, from the Callovian of Madagascar, differs in having a more pointed posterior end as well as a different hinge.

G. manyuliensis sp. nov. derives its name from the Manyuli stream, Mandawa Anticline.

Family **PROTOCYTHERIDAE** Ljubimova 1955

Genus ***PROCYTHERIDEA*** Peterson 1954

The incorrect assignment of a large number of species in the European Mesozoic to this genus has been dealt with fully by Bate (1963 : 214) and Lord (1972 : 326). The genus is thus restricted to species having a triangular lateral outline. *Procytheridea* was placed in the family Protocytheridae in Moore (1961 : 330) and this assignment is retained here.

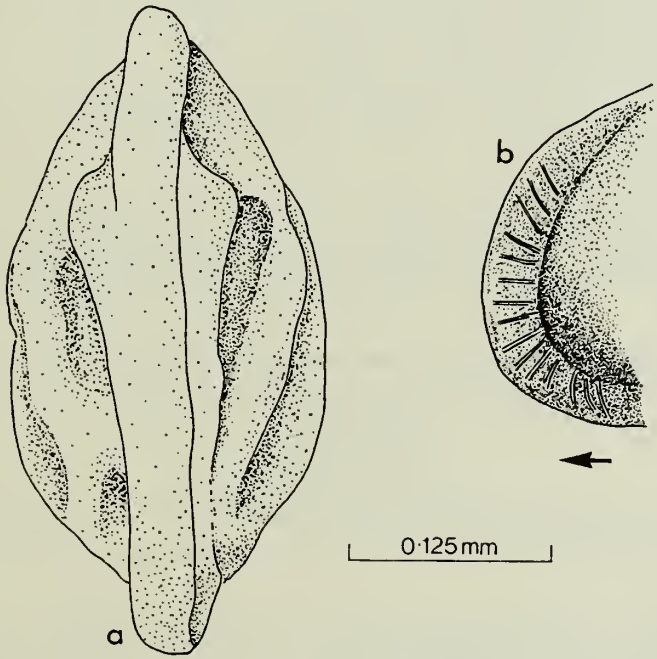

Fig. 15a, b. *Procytheridea disparlateralis* sp. nov. Dorsal and anterior end to show marginal pore canals, carapace, paratype Io.6136.

Procytheridea disparlateralis sp. nov.

Pl. 8, figs 7, 8 ; Text-fig. 15a, b

Diagnosis. *Procytheridea* with single oblique ridge bounded by two depressions on right valve, and with tri-radiate ridge pattern on left valve.

Holotype. Io.6135, sample B97 (Pl. 8, fig. 7).

Paratypes. Io. 6134 and Io.6136, sample B97.

Horizon and Locality. Middle Callovian, sample B97, Mandawa Anticline (Text-fig. 3).

Description. **Carapace** triangular with larger left valve possessing a triradiate ridge pattern and the smaller right valve having a single oblique ridge with a broad shallow depression on either side. The absence of a ventro-lateral depression in the right valve produces this variation of ornamentation. **Eye swelling** situated in the region of the anterior cardinal angle, particularly visible in dorsal view (Text-fig. 15a). Internal details not known apart from the anterior **marginal pore canals** as seen from the exterior (Text-fig. 15b).

Dimensions. Holotype, Io.6135, carapace (Pl. 8, fig. 7), length 0·46 mm ; height 0·27 mm ; width 0·24 mm. Paratype, Io.6134, carapace (Pl. 8, fig. 8), length 0·44 mm ; height 0·25 mm ; width 0·20 mm.

Discussion. *Procytheridea disparlateralis* sp. nov. is so named because of the difference in ornamentation between the right and the left valve. It is similar in both ornamentation and shell outline to *Progonocythere falcula* Grekoff 1963, from the Callovian of Madagascar ; it also resembles Ostracod Nr. 4 of Lutze (Simon & Bartenstein 1962), from the Callovian of Germany, and less closely *Procytheridea martini* Bizon 1958, from the Oxfordian of France and Switzerland (Oertli 1959). Although morphologically close to these species *Procytheridea disparlateralis* may be distinguished from all three by its ridge pattern and associated shell depressions.

Family **TRACHYLEBERIDIDAE** Sylvester-Bradley 1948

Genus ***CYTHERETTA*** Müller 1894

'*Cytheretta*' sp.

Pl. 10, figs 1, 2

Material. A single carapace, Io.6173, sample B114.

Horizon and Locality. Middle Callovian, sample B114, Mandawa Anticline (Text-fig. 3).

Discussion. No internal details of this ostracod are available. Externally it closely resembles species of *Cytheretta* Müller 1894 and *Paracytheretta* Triebel 1941. The present species is considerably older than the known ranges of these two genera and could be an ancestral form.

Progonocythere grumosa Ljubimova & Mohan 1960, from the Callovian of India (Kutch), has some similarity of outline but lacks the postero-dorsal projection of '*Cytheretta*' and most probably belongs to the genus *Protocythere*, although no internal details were recorded.

Dimensions. Io.6173, carapace, length 0·54 mm ; height 0·31 mm ; width 0·28 mm.

Genus ***MANDAWACYTHERE*** nov.

Type Species. *Mandawacythere striata* sp. nov.

Diagnosis. Trachyleberididae having elongate dimorphic carapace. Left valve larger than right. Hinge lophodont. Duplicature anteriorly possessing small

vestibule and few, straight marginal pore canals. Muscle scars having ventro-median adductor scar divided ; large frontal scar with smaller scar situated in front and small antero-ventral mandibular scar.

Discussion. *Mandawacythere* gen. nov. (gender feminine), named after its location in the Mandawa region, is placed here in the Trachyleberididae on the muscle scar pattern. This assignment should, however, be considered as tentative at the present time. Certainly it is not possible to place *Mandawacythere* in any of the subfamily groups listed by Hazel (1967) for either the trachyleberids or the hemicytherids. The absence of a subcentral tubercle together with the divided adductor scar could lend weight to the consideration of *Mandawacythere* as being an early hemicytherid, but the simple lophodont hinge and limited number of marginal pore canals make any definite assignment difficult.

Mandawacythere striata sp. nov.

Pl. 10, figs 3–10 ; Text-fig. 16a–b

1963 Ostracod 38a Grekoff : 1759, pl. 10, figs 248-9.

Diagnosis. *Mandawacythere* having 10–11 low, longitudinal ridges confluent at their posterior ends. Shell surface punctuate.

Holotype. Io.6174, right valve, sample B219 (Pl. 10, figs 3, 4, 10 ; Text-fig. 16b).

Paratypes. Io.6175–81, samples B219 and B223.

Horizon and Locality. (?) Lower Tithonian, samples B219 and B223, Mandawa Anticline (Text-fig. 3).

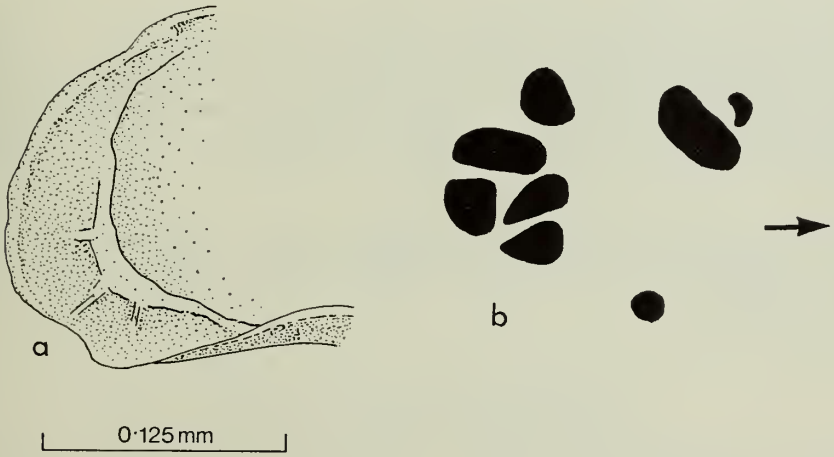

Fig. 16a, b. *Mandawacythere striata* sp. nov. a. Anterior duplicature, female right valve, paratype Io.6181. b. Muscle scars, female right valve, holotype Io.6174. × 735.

Description. **Carapace** elongate, especially in the male. Male dimorph having 10 longitudinal lateral ridges, female dimorph 11. Interspaces between ridges punctate. **Hinge** lophodont with very long median element. **Duplicature** not clearly seen although in one specimen a small anterior vestibule is present together with a few, straight, **marginal pore canals** (Text-fig. 16a). **Muscle scars** consist of four adductor scars of which the ventro-median scar is divided ; the frontal scar is large, oval, with a small ancillary scar in front ; mandibular scar small, situated antero-ventrally (Pl. 10, fig. 10 ; Text-fig. 16b).

Dimensions. Holotype, Io.6174, female right valve (Pl. 10, figs 3, 4, 10 ; Text-fig. 16b), length 0·37 mm ; height 0·19 mm. Paratypes : Io.6175, male right valve (Pl. 10, figs 8, 9), length 0·43 mm ; height 0·19 mm. Io.6176, juvenile ? right valve (Pl. 10, fig. 7), length 0·29 mm ; height 0·15 mm. Io.6177, female carapace (Pl. 10, fig. 5), length 0·35 mm ; height 0·17 mm ; width 0·15 mm. Io.6178, female carapace (Pl. 10, fig. 6), length 0·34 mm ; height 0·17 mm ; width 0·17 mm.

Discussion. *Mandawacythere striata* sp. nov. is totally unlike any previously described species with the exception of Ostracod 38a of Grekoff (1963), recorded from the Kimmeridgian of Madagascar and by Guha (1975?) from the Kimmeridgian to Portlandian of Kutch (India). Ostracod 38a, however, has fewer lateral ridges and appears to be closer to the paratype Io.6176 (Pl. 10, fig. 7), considered here to be a possible juvenile instar. Should this prove not to be so it will be necessary to remove this specimen from the species, and Ostracod 38a from the synonymy.

Family **UNCERTAIN**

Genus ***RHADINOCYTHERE*** nov.

Derivation of Name. Greek, *ῥαδινός*, slender, + *cythere*. Gender, feminine.

Type Species. *Rhadinocythere gracilis* sp. nov.

Diagnosis. Small (length c 0·41 mm) genus of Cytheracea having very slender carapace (width c 0·12 mm) highest at anterior half. Lateral surface punctate and with three primary lateral ridges. Anterior duplicature with median vestibule ; marginal pore canals straight, few in number. Hinge lophodont. Left valve larger than right.

Discussion. This distinct and small ostracod is recorded only from the Middle or Upper Kimmeridgian of the Mandawa Anticline Area. Unfortunately no details of the muscle scars have been seen thus making it impossible to assign the genus to a known family.

Rhadinocythere gracilis sp. nov.

Pl. 10, figs 11–14 ; Pl. 11, figs 1–4 ; Text-fig. 17

Diagnosis. *Rhadinocythere* with three primary lateral ridges and two subordinate ridges interleaved in anterior half.

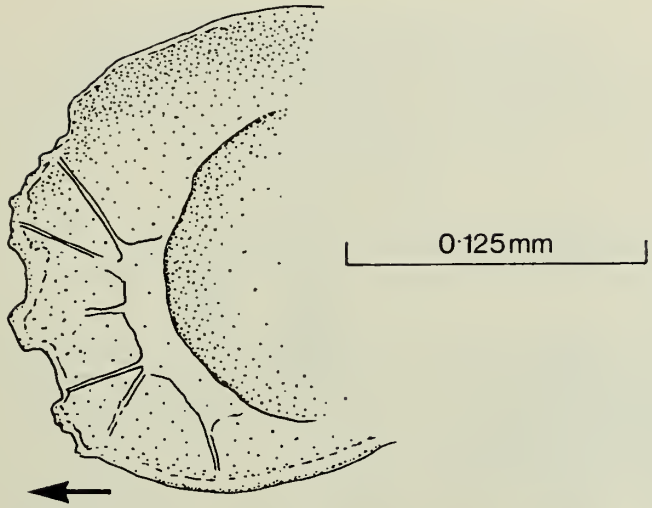

FIG. 17. *Rhadinocythere gracilis* sp. nov. Anterior duplicature with vestibule and marginal pore canals, right valve, paratype Io.6188.

HOLOTYPE. Io.6182, carapace, sample B223 (Pl. 10, fig. 14).

PARATYPES. Io.6183–9, sample B223.

HORIZON AND LOCALITY. Middle or Upper Kimmeridgian, samples B219 and B223, Mandawa Anticline (Text-fig. 3).

DESCRIPTION. **Carapace** oval, highest at anterior end ; slender in dorsal or ventral view. Shell surface finely punctate ; additional ornamentation consisting of three primary lateral ridges extending for the greater part of the length of the valve and having two subordinate ridges interleaved in the anterior half. **Hinge** lophodont with long median element. **Muscle scars** not seen. Anterior **duplicature** broad with distinct vestibule (Text-fig. 17). **Marginal pore canals** few in number and straight (Text-fig. 17).

DIMENSIONS. Holotype, Io.6182, carapace (Pl. 10, fig. 14), length 0·41 mm ; height 0·21 mm ; width 0·14 mm. Paratypes : Io.6183, carapace (Pl. 11, fig. 4), length 0·37 mm ; height 0·17 mm ; width 0·12 mm. Io.6184, carapace (Pl. 10, fig. 11), length 0·38 mm ; height 0·18 mm ; width 0·11 mm. Io.6185, right valve (Pl. 10, fig. 13 ; Pl. 11, figs 1, 2), length 0·38 mm ; height 0·18 mm. Io.6186, left valve (Pl. 10, fig. 12), length 0·38 mm ; height 0·19 mm. Io.6187, carapace (Pl. 11, fig. 3), length 0·34 mm ; height 0·17 mm ; width 0·12 mm.

DISCUSSION. No ostracod comparable at either generic or specific level is known from the Mesozoic around the Indian Ocean. From its size and rather delicate shell structure *Rhadinocythere gracilis* sp. nov. was most probably a phytal dweller.

Family **CYTHERURIDAE** Müller 1894
Subfamily **CYTHERURINAE** Müller 1894
Genus ***EUCYTHERURA*** Müller 1894

Eucytherura sp.

Pl. 11, figs 5, 6

Material. A single left valve, Io.6190, sample B97.

Horizon and Locality. Middle Callovian, sample B97, Mandawa Anticline (Text-fig. 3).

Discussion. A single left valve, highly ornamented and having a low eye swelling below the anterior cardinal angle. Internally the hinge is rather poorly preserved but the median bar appears to be denticulate. The duplicature lacks a vestibule.

The earliest recorded appearance of *Eucytherura* still remains from the Upper Lias of England (Bate & Coleman 1975).

Dimensions. Io.6190, left valve, length 0·39 mm ; height 0·23 mm.

Genus ***PROCYTHERURA*** Whatley 1970 emend. Bate & Coleman 1975

In the original diagnosis the hinge was recorded as lophodont and the frontal muscle scar as heart-shaped. The hinge in *Procytherura* is in fact entirely smooth but has the ends of the median element expanded, thereby becoming holoperatodont (Bate 1972 : 45) rather than lophodont. The frontal muscle scar varies from heart-shaped to V-shaped. The genus has a known range of Lower Jurassic (Bate & Coleman 1975) to Upper Jurassic (Whatley 1970) in Great Britain and here is recorded from the Upper Jurassic of Tanzania.

Procytherura aerodynamica sp. nov.

Pl. 11, figs 7–16 ; Pl. 12, figs 1–3 ; Text-fig. 18a–c

1974 Indet. sp. E. Oertli : 949, pl. 7, fig. 5.

Diagnosis. *Procytherura* having stream-lined carapace outline, slightly alate postero-ventrally. Shell surface decorated with large pits and fine puncta.

Holotype. Io.6191, male carapace, sample B219 (Pl. 11, fig. 7).

Paratypes. Io.6192–208, samples B219 and B223.

Horizon and Locality. Lower and Middle or Upper Kimmeridgian, samples B103a, B219, B222 and B223, Mandawa Anticline (Text-fig. 3).

Description. **Carapace** oval in adult dimorphs with a gradual taper towards the posterior end. In juvenile instars the dorsal margin is more strongly curved producing a distinct caudal process (Pl. 11, figs 10, 11). The posterior ventro-lateral alation of the carapace is more strongly developed in the adult instar. Left valve larger than the right. Cardinal angles distinct ; no eye swelling. Shell surface ornamented with a fine punctation and, in adult instars, larger pits (Pl. 11, figs 7, 8,

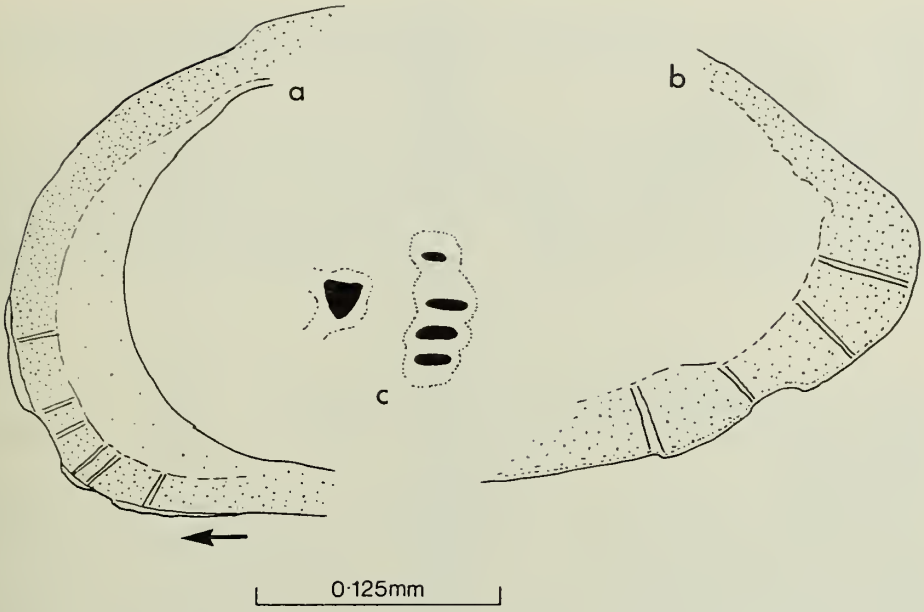

FIG. 18a–c. *Procytherura aerodynamica* sp. nov. a, b. Anterior duplicature with vestibule and marginal pore canals and posterior duplicature, male right valve, paratype Io.6208. c. Muscle scars, female right valve, paratype Io.6207.

12, 13). The juveniles possess the fine puncta only. **Hinge** holoperatodont; median element long, smooth and expanded at both ends. **Duplicature** broad with large anterior vestibule. No posterior vestibule present. **Marginal pore canals** straight, few in number. Anterior with narrow **flange** (Text-fig. 18a). **Muscle scars** consist of four oval, rather elongate adductor scars with a large heart-shaped frontal scar.

DIMENSIONS. Holotype, Io.6191, male carapace (Pl. 11, fig. 7), length 0·54 mm; height 0·27 mm; width 0·21 mm. Paratypes: Io.6192, female carapace (Pl. 11, fig. 8), length 0·50 mm; height 0·26 mm; width 0·22 mm. Io.6193, female right valve (Pl. 11, fig. 13), length 0·50 mm; height 0·26 mm. Io.6194, male carapace (Pl. 12, fig. 2), length 0·56 mm; height 0·27 mm; width 0·21 mm. Io.6195, juvenile carapace (Pl. 12, fig. 3), length 0·46 mm; height 0·24 mm; width 0·18 mm. Io.6196, female right valve (Pl. 11, fig. 15), length 0·49 mm; height 0·26 mm. Io.6197, male left valve (Pl. 11, fig. 14), length 0·54 mm; height 0·27 mm. Io.6198, female left valve (Pl. 12, fig. 1), length 0·46 mm; height 0·24 mm. Io.6199, juvenile right valve (Pl. 11, fig. 9), length 0·42 mm; height 0·24 mm. Io.6200, juvenile right valve (Pl. 11, figs 10, 16), length 0·44 mm; height 0·23 mm. Io.6202, male right valve (Pl. 11, fig. 12), length 0·51 mm; height 0·24 mm. Io.6203, juvenile left valve (Pl. 11, fig. 11), length 0·47 mm; height 0·22 mm.

DISCUSSION. *Procytherura aerodynamica* sp. nov. differs from European species of the genus by lacking the lateral ridges or reticulation found in all species so far

described. The eye swelling and dorso-median sulcation are also missing but despite this it is preferred to place *aerodynamica* in *Procytherura* until the description of further species shows whether the genus should be more broadly diagnosed or subdivided.

Indet. sp. E described by Oertli (1974) from core 30, site 260 off Western Australia is conspecific with *P. aerodynamica*. This has been confirmed by Oertli (personal communication) from material subsequently sent to him. The geographical range of *P. aerodynamica* is thus extended. The sample from which Indet. sp. E was recovered may now, almost certainly, be regarded as being of Kimmeridgian age.

Procytherura sp.

Pl. 12, fig. 4

Material. A single carapace, Io.6209, sample B97.

Horizon and Locality. Middle Callovian, sample B97, Mandawa Anticline (Text-fig. 3).

Discussion. That this rare ostracod is more closely allied to the European species of *Procytherura* than it is to the Tanzanian *P. aerodynamica* is evidenced by the surface ornamentation of low, evenly spaced lateral ridges and, in dorsal view, a distinct median constriction. An eye swelling might be present here but the preservation of the specimen makes this difficult to determine. No internal details have been observed.

Dimensions. Io.6209, carapace, length 0·30 mm; height 0·15 mm; width 0·12 mm.

Subfamily **CYTHEROPTERINAE** Hanai 1957

Genus ***CYTHEROPTERON*** Sars 1866

Subgenus ***INFRACYTHEROPTERON*** Kaye 1964

Cytheropteron (? Infracytheropteron) aitkeni sp. nov.

Pl. 12, figs 5–13; Text-fig. 19a–c

Diagnosis. Dimorphic species of *Cytheropteron* having simple hinge consisting of smooth groove in left valve articulating with dorsal bar in right valve. Carapace strongly alate with broad median sulcus. Eye swelling indistinct, lacking or strongly developed. Shell surface pitted. Left valve overlapping right along dorsal margin. Inner margin and line of concrescence coincide.

Holotype. Io.6210, female left valve, sample B219 (Pl. 12, fig. 7).

Paratypes. Io.6211–19 and Io.6240, samples B219, B223, B104a, and 107a.

Horizon and Locality. Lower and Middle or Upper Kimmeridgian, samples B219, B223, B107a and B104a, Mandawa Anticline (Text-fig. 3).

Description. **Carapace** subrectangular with broad alae and wide median sulcus. Ala terminating in a spine. Anterior and posterior margins sometimes denticulate (Pl. 12, figs 8, 12). Male dimorph more elongate than female. Left valve overlaps

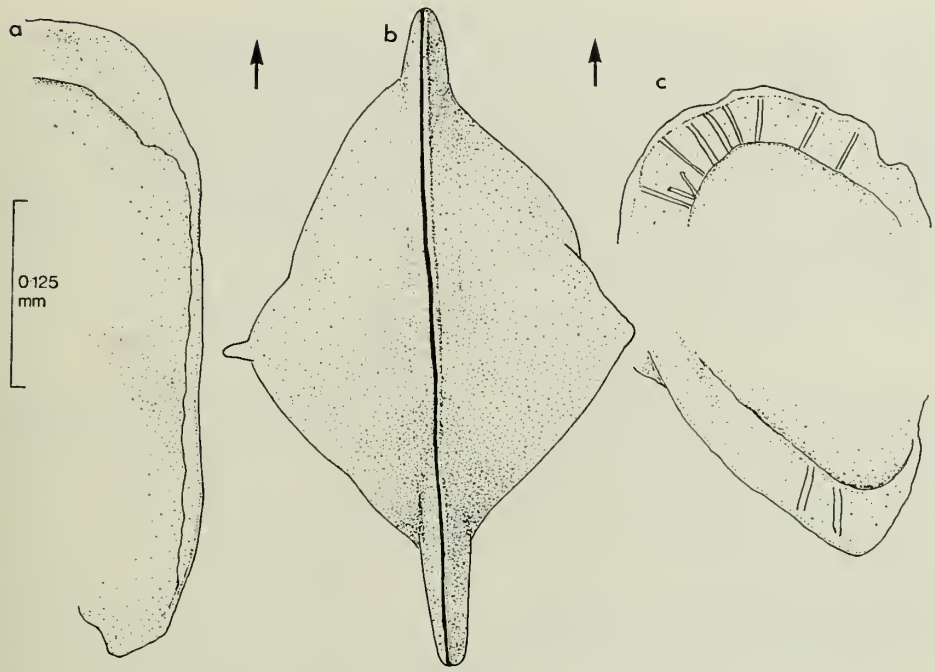

FIG. 19a–c. *Cytheropteron* (? *Infracytheropteron*) *aitkeni* sp. nov. a. Internal view, male right valve dorsal margin and duplicature, paratype Io.6216. b. Dorsal view, female carapace, paratype Io.6211. c. Anterior and posterior duplicatures to show marginal pore canals, female right valve, paratype Io.6240.

right dorsally (Pl. 12, fig. 8) but ventrally there is no overlap (Text-fig. 19b). Shell surface pitted with furrow parallel to dorsal margin. **Eye swelling** usually poorly developed but may be prominent (Pl. 12, fig. 9). **Hinge** consisting of a long, smooth groove in the left valve into which fits the dorsal bar of the right valve, slightly downset from the dorsal edge of the valve (Pl. 12, fig. 12). **Duplicature** of moderate width with inner margin and line of concrescence coinciding. Approximately 9 straight anterior **marginal pore canals** and about 2 posterior canals (Text-fig. 19c). **Muscle scars** consist of an oblique row of four oval to rounded adductor scars with a large V-shaped frontal scar (Pl. 12, fig. 13).

DIMENSIONS. Holotype, Io.6210, female left valve (Pl. 12, fig. 7), length 0·39 mm ; height 0·24 mm. Paratypes : Io.6211, female carapace (Pl. 12, fig. 8 ; Text-fig. 19b), length 0·43 mm ; height 0·26 mm ; width 0·27 mm ; Io.6212, male left valve (Pl. 12, fig. 11), length 0·43 mm ; height 0·22 mm. Io.6213, female right valve (Pl. 12, fig. 6), length 0·37 mm ; height 0·21 mm. Io.6214, female left valve (Pl. 12, figs 10, 13), length 0·42 mm ; height 0·24 mm. Io.6215, female left valve (Pl. 12, fig. 9), length 0·37 mm ; height 0·21 mm. Io.6216, male right valve (Pl. 12, fig. 12), length 0·38 mm ; height 0·17 mm. Io.6217, juvenile left valve (Pl. 12, fig. 5), length 0·31 mm ; height 0·18 mm.

Discussion. *Cytheropteron* (? *Infracytheropteron*) *aitkeni* sp. nov. is named after Dr W. G. Aitken, formerly geologist with the Tanganyika Geological Survey.

This species is placed in the subgenus *Infracytheropteron* with a query for two reasons. Firstly, an eye swelling, a feature not so far recorded in species of this subgenus, is present ; secondly, the hinge, although having smooth elements, is of the adont and not of the holoperatodont type. The external appearance of *C.* (? *I.*) *aitkeni* sp. nov. is such that it closely resembles the European Lower Jurassic *Cytheropteron* (*Cytheropteron*) *alafastigatum* Fischer 1962 but is distinguished by its hinge and the development of an eye swelling.

Cytheropteron (Infracytheropteron) ndaui sp. nov.

Pl. 13, figs 5–10 ; Text-fig. 20a–e

Diagnosis. Small dimorphic species of *Infracytheropteron* having rectangular outline and broadly arched dorsal margin ; keel-like alae producing broad, flattened venter in female, venter convex in male.

Holotype. Io.6225, female carapace, sample B223 (Pl. 13, fig. 5).

Paratypes. Io.6226–9 and Io.6232, sample B223.

Horizon and Locality. Middle or Upper Kimmeridgian, samples B219 and B223, Mandawa Anticline (Text-fig. 3).

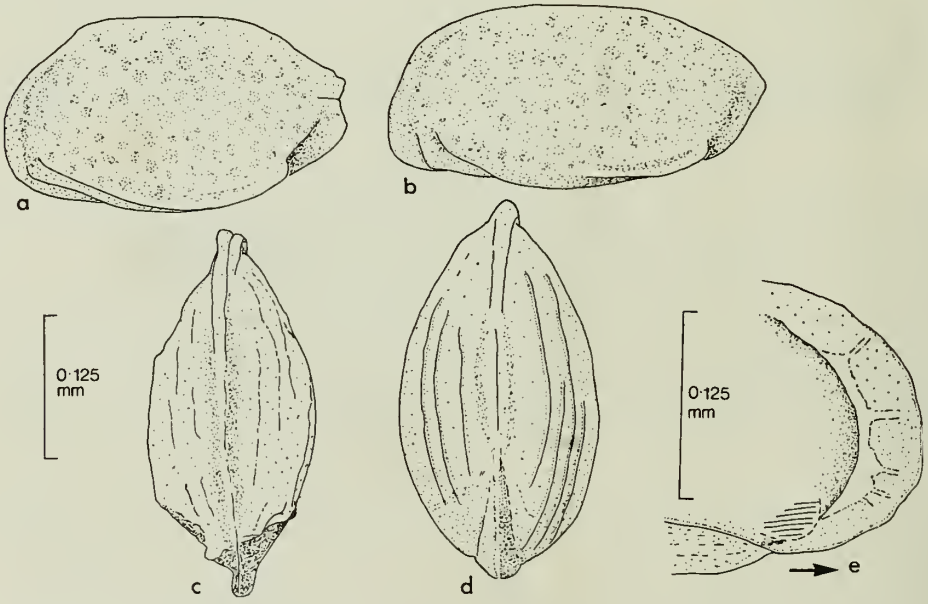

Fig. 20a–e. *Cytheropteron* (*Infracytheropteron*) *ndaui* sp. nov. a. External view, female left valve, paratype Io.6226. b. External view, male left valve, paratype Io.6229. c. Ventral view, female carapace, holotype Io.6225. d. Ventral view, male carapace, paratype Io.6227. e. Anterior duplicature, vestibule and pore canals, female left valve, paratype Io.6232.

DESCRIPTION. **Carapace** rectangular in outline; males more elongate than females. Both dimorphs convex in dorsal view; males convex in ventral view, females with flattened venter (Text-fig. 20c, d). Alae keel-like, bordering venter. Caudal process more pronounced in female dimorph. Dorsal margin very broadly arched with distinct cardinal angles. Left valve larger than the right. **Hinge** holoperatodont: terminal teeth of right valve smooth; median groove terminally expanded, smooth. Left valve with complementary smooth structures although the median bar is rather worn in the material available. **Duplicature** of moderate width: the inner margin and line of concrescence do not coincide anteriorly and a narrow vestibule is present (Text-fig. 20e). **Marginal** pore canals short, straight and few in number. **Muscle scars** not seen.

DIMENSIONS. Holotype. Io.6225, female carapace (Pl. 13, fig. 5; Text-fig. 20c), length 0·35 mm; height 0·20 mm; width 0·17 mm. Paratypes: Io.6226, female left valve (Pl. 13, figs 6, 8; Text-fig. 20a), length 0·34 mm; height 0·19 mm. Io.6227, male carapace (Pl. 13, fig. 10; Text-fig. 20d), length 0·38 mm; height 0·20 mm; width 0·20 mm. Io.6228, female right valve (Pl. 13, fig. 7), length 0·32 mm; height 0·17 mm. Io.6229, male left valve (Pl. 13, fig. 9; Text-fig. 20b), length 0·37 mm; height 0·18 mm.

DISCUSSION. *Cytheropteron* (*Infracytheropteron*) *ndaui* sp. nov. is named after Mr Alfred Ndau, Field Assistant with the Tanganyika Geological Survey during the 1965 BMNH expedition to Tanzania. The species differs from others of the subgenus on the combination of shape, keel-like alae and ornamentation.

Subgenus **Uncertain**

Cytheropteron grekoffi sp. nov.

Pl. 12, fig. 14; Pl. 13, figs 1, 2

DIAGNOSIS. Oval species of *Cytheropteron* having narrowly rounded posterior end lacking a caudal process. Shell surface coarsely pitted. Marginal borders broad.

HOLOTYPE. Io.6220, carapace, sample BM86 (Pl. 13, fig. 1).

PARATYPES. Io.6221–4, samples B2 and B67.

HORIZON AND LOCALITY. Upper Oxfordian, samples BM86, B2 and B67, Wami River Area (Text-fig. 2).

DESCRIPTION. **Carapace** lacking caudal process, oval in outline. Ventrolateral border convex rather than alate, overhanging ventral surface. Shell ornamented with large pits. Broad marginal border extends around anterior, along venter and around posterior end. **Internal details** not known.

DIMENSIONS. Holotype. Io.6220, carapace (Pl. 13, fig. 1), length 0·50 mm; height 0·30 mm; width 0·25 mm. Paratypes: Io.6221, carapace (Pl. 13, fig. 2), length 0·41 mm; height 0·26 mm; width 0·18 mm. Io.6222, carapace (Pl. 12, fig. 14), length 0·41 mm; height 0·26 mm; width 0·23 mm.

Discussion. *Cytheropteron grekoffi* sp. nov. cannot yet be placed in any of the subgenera of *Cytheropteron* owing to the absence of internal information. Externally this species is closely similar to *Cytheropteron* 1040 of Grekoff (1963), from the Kimmeridgian of Madagascar, but tends to be more robust, differing in having a more obliquely angled postero-ventral border.

Cytheropteron sp.

Pl. 13, figs 3, 4

Material. Two specimens, Io.6230–1, sample B223.

Horizon and Locality. Middle or Upper Kimmeridgian, sample B223, Mandawa Anticline (Text-fig. 3).

Discussion. *Cytheropteron* sp. bears some similarity to *Cytheropteron corrosum* Grekoff 1963, from the Portlandian of Madagascar, but is more elongate in outline and has a different ornamental pattern of pits.

Dimensions. Io.6230, carapace (Pl. 13, fig. 4), length 0·32 mm ; height 0·16 mm ; width 0·13 mm. Io.6231, carapace (Pl. 13, fig. 3), length 0·32 mm ; height 0·17 mm ; width 0·13 mm.

Genus ***PARACYTHERIDEA*** Müller 1894

Paracytheridea mandawaensis sp. nov.

Pl. 14, figs 1–9

Diagnosis. *Paracytheridea* having elongate carapace with short, rather broad alae. Shell ornamented with three carinae : dorsal, oblique median and ventro-lateral. Shell surface reticulate ; reticulae having secondary reticulation.

Holotype. Io.6233, carapace, sample B223 (Pl. 14, figs 1, 6).

Paratypes. Io.6234–9, sample B223.

Horizon and Locality. Middle or Upper Kimmeridgian, samples B219 and B223, Mandawa Anticline Area (Text-fig. 3).

Description. **Carapace** outline as illustrated. The alae are rather short and broad with their greatest development in the posteroventro-lateral region. This produces a flat ventral surface widening towards the posterior end. Carapace convex in dorsal view. **Ornamentation** consists of a basic surface reticulation, the reticulae of which possess secondary reticulae (Pl. 14, fig. 5). Three longitudinal carinae, the lowermost extending along the ala to meet the anterior margin in the ventral half of the valve. The median carina extends obliquely across the valve and in some specimens (Pl. 14, figs 1, 3) is complete, while in others (Pl. 14, figs 2, 4) it is discontinuous, forming a plexus of carinae. The dorsal-most carina extends along the dorsal margin, cuts through the eye node and joins the anterior margin in the dorsal half of the valve ; posteriorly the dorsal carina fuses with the median carina at the posterior cardinal angle in most valves (Pl. 14, figs 1, 2, 4) but not in specimen Io.6235 (Pl. 14, fig. 3). **Eye node** distinct, set back from the anterior cardinal

angle in the holotype (Pl. 14, fig. 1) but may be situated much closer to it in some individuals (Pl. 14, fig. 3). **Hinge** difficult to determine because of the state of preservation : in the left valve the terminal elements appear to be loculate but the median bar is too eroded to identify with certainty ; hinge details not observed in the right valve. **Muscle scars** consist of an oblique row of four elongate adductor scars with a large V-shaped frontal scar (Pl. 14, fig. 6). **Duplicature** of moderate width with the inner margin and line of concrescence coinciding. **Marginal pore canals** have not been observed.

Dimensions. Holotype, Io.6233, carapace (Pl. 14, figs 1, 6), length 0·36 mm ; height 0·17 mm ; width 0·15 mm. Paratypes : Io.6234, right valve (Pl. 14, fig. 2), length 0·37 mm ; height 0·18 mm. Io.6235, left valve (Pl. 14, figs 3, 6), length 0·35 mm ; height 0·17 mm. Io.6236, carapace (Pl. 14, fig. 7), length 0·35 mm ; height 0·16 mm ; width 0·15 mm. Io.6237, carapace (Pl. 14, fig. 8), length 0·35 mm ; height 0·17 mm ; width 0·17 mm. Io.6238, left valve (Pl. 14, fig. 9), length 0·36 mm ; height 0·16 mm. Io.6239, carapace (Pl. 14, fig. 4), length 0·38 mm ; height 0·19 mm ; width 0·17 mm.

Discussion. *Paracytheridea mandawaensis* sp. nov. is very close to *Orthonotacythere* (*Acrocythere*) 129 described by Grekoff (1963), from the Portlandian of Madagascar, in both size and general appearance. There are, however, some differences, namely the absence of an eye node and a dorsal carina in Grekoff's species which indicate that the two are not conspecific.

Subfamily **UNCERTAIN**

Genus ***ACROCYTHERE*** Neale 1960

Acrocythere ? tricostata sp. nov.

Pl. 13, figs 11–14 ; Text-fig. 21

Diagnosis. Species placed with query in *Acrocythere*, having three longitudinal carinae of which the median carina has a double U-bend at valve centre. Shell surface smooth.

Holotype. Io.6241, left valve, sample B223 (Pl. 13, fig. 11).

Paratypes. Io.6242–5, samples B219 and B223.

Horizon and Locality. Middle or Upper Kimmeridgian, samples B219 and B223, Mandawa Anticline (Text-fig. 3).

Description. **Carapace** small, oval in outline with distinct posterior taper. In the right valve a concave postero-dorsal slope produces a short narrowly rounded caudal process. The outline of the left valve, as illustrated (Pl. 13, fig. 11), is considerably different and the line of greatest length is situated higher up on the valve than in the right. **Ornamentation** consists of three longitudinal carinae that converge towards the anterior margin. The dorsal carina follows the dorsal and the antero-dorsal margins, passing through the eye node. The median carina is obliquely orientated and sinuous ; the sinuosity producing two U-shaped bends at about valve centre. The lowermost carina follows the outer edge of the wing-like

FIG. 21. *Acrocythere* ? *tricostata* sp. nov. Muscle scars, external view, right valve, paratype Io.6245.

development of the valve. **Hinge** appears to be holoperatodont, curved and almost sinuous. All elements are smooth, with the median element expanded terminally (Pl. 13, fig. 12). The apparent absence of dentition may be because of the state of preservation but at the same time no loculae have been observed. **Duplicature** rather broad ; inner margin and line of concrescence coinciding. **Marginal pore canals** long and straight, few in number although the precise number has not been observed. **Muscle scars** consist of a slightly curved row of four oval adductor scars with an antero-dorsal V-shaped frontal scar and a small, round, antero-ventral mandibular scar.

DIMENSIONS. Holotype, Io.6241, left valve (Pl. 13, fig. 11), length 0·35 mm ; height 0·20 mm. Paratypes : Io.6242, left valve (Pl. 13, fig. 13), length 0·35 mm ; height 0·19 mm. Io.6243, right valve (Pl. 13, fig. 14), length 0·37 mm ; height 0·21 mm. Io.6244, right valve (Pl. 13, fig. 12), length 0·37 mm ; height 0·21 mm.

DISCUSSION. The carapace outline, rather sigmoid dorsal margin and median hinge element, together with the presence of three lateral ridges and absence of reticulation, sets *Acrocythere* ? *tricostata* sp. nov. apart from all other species of the genus. Although species of *Acrocythere* in general possess only two lateral ridges, close examination of the type species reveals a tendency to develop a dorsal structure. Because of this it is preferred to place the present species in *Acrocythere* with a query rather than to erect a new genus at this time. The probability that a new genus may be necessary for this southern hemisphere species is, however, accepted.

Genus ***LOONEYELLA*** Peck 1951

Looneyella africana sp. nov.

Pl. 14, figs 10–12 ; Text-fig. 22a–d

DIAGNOSIS. *Looneyella* having five tubercles : two situated in postero-dorsal region, one antero-median and one antero-dorsal in position. A fifth tubercle is

situated at postero-ventral termination of broad, curved ridge extending down from eye node. Shell surface reticulate.

HOLOTYPE. Io.6246, left valve, sample B223 (Pl. 14, fig. 10).

PARATYPES. Io.6247–50, samples B219 and B223.

HORIZON AND LOCALITY. Middle or Upper Kimmeridgian, samples B219 and B223, Mandawa Anticline (Text-fig. 3).

DESCRIPTION. **Carapace** dimorphic, quadrate to rectangular in outline ; broadly rounded anteriorly, posterior end triangular. Line of greatest length situated in dorsal third of carapace. **Ornamentation** consisting of four distinct tubercles as diagnosed (Text-fig. 22a, b). Shell surface coarsely reticulate, the reticulae passing over the tubercles (Pl. 14, fig. 10). **Hinge** poorly preserved ; left valve with terminal locellate sockets and a median bar, right valve with complementary structures. The median bar of the left valve appears to be smooth but this may be due to the state of preservation. **Duplicature** broad : inner margin and line of concrescence coincide. **Marginal pore canals** long and straight : 6 anteriorly and 3 posteriorly (Text-fig. 22c, d). **Muscle scars** not seen.

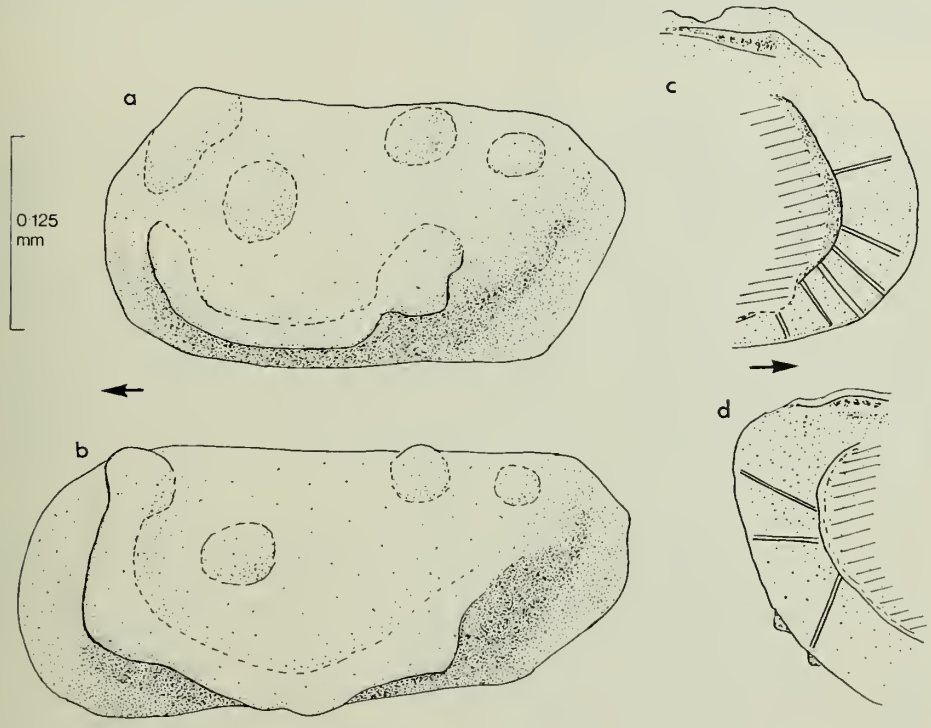

FIG. 22a–d. *Looneyella africana* sp. nov. a. External view, female left valve, holotype Io.6246. b. External view, male left valve, paratype Io.6248. c, d. Anterior and posterior duplicatures with marginal pore canals, female left valve, paratype Io.6249.

Dimensions. Holotype, Io.6246, female left valve (Pl. 14, fig. 10 ; Text-fig. 22a), length 0·32 mm ; height 0·16 mm. Paratypes : Io.6247, male right valve (Pl. 14, fig. 11), length 0·37 mm ; height 0·18 mm. Io.6248, male left valve (Pl. 14, fig. 12 ; Text-fig. 22b), length 0·37 mm ; height 0·17 mm. Io.6250, female right valve, length 0·36 mm ; height 0·19 mm.

Discussion. The degree of development of the tubercles in *Looneyella africana* sp. nov. is variable in that the most posterior postero-dorsal tubercle may be only very poorly developed. Likewise the tubercle at the posterior end of the ventro-lateral ridge may be variable in its development. In some specimens the ventro-lateral ridge itself may become nodose.

Originally (Bate 1975) this species was assigned to the genus *Orthonotacythere* Alexander 1933, which it closely resembles on carapace outline and tuberculate surface ornamentation. However, *Looneyella* differs from *Orthonotacythere* in the development of a curved, ventro-lateral ridge that tends to turn upwards anteriorly and fuse with the eye node. Closer examination of this East African species confirmed that it should more accurately be placed in *Looneyella*.

L. africana differs from the Cretaceous *L. monticula* (Jones 1893) and the Jurassic *L. subtilis* Oertli 1959 in the more rectangular carapace outline, reticulate shell surface and position of the tubercles.

IV. FAUNAL ASSEMBLAGES

The ostracods described in this paper were obtained from five stratigraphical units (see Table 1), each unit having its own ostracod faunal assemblage and each assemblage characterized by a species of the ostracod genus *Majungaella*. The ostracod faunas are described in ascending stratigraphical order.

Middle Callovian fauna. *Majungaella mundula* (Grekoff) in association with (a) in the Wami River Area : *Paracypris* sp. B, *Paracypris* aff. *contermia*, *Cytherella masuguluensis*, *Cytherella* cf. *collapsa*, *Pirileberis prognata*, *Amicytheridea ihopyensis* and *Afrocytheridea laevigata*. (b) in the Mandawa Anticline : *Cytherella knysnaensis*, *Cytherelloidea brentonensis*, *Amicytheridea ihopyensis*, *Amicytheridea triangulata*, *Afrocytheridea faveolata*, '*Cytheretta*' sp., *Darwinula* sp., *Bairdia* sp. C, *Asciocythere* sp., *Procytheridea disparlateralis*, *Procytherura* sp., *Monoceratina* sp. B and *Eucytherura* sp.

The two ostracod assemblages listed above come from Middle Callovian sediments dated on ammonite evidence as belonging to the *anceps* Zone. They are, therefore, of the same age. Within the time span of an ammonite zone it is possible that more than a single ostracod fauna developed. Here the two assemblages are linked by the common ostracods *Majungaella mundula* and *Amicytheridea ihopyensis*, but it is probably significant that the two assemblages are not only widely separated geographically but that the southern fauna contains evidence, the presence of charophytes and of the ostracod *Darwinula* sp., of the closeness of land and the influx of fresh water. Thus the differences in faunas could be attributed either to differing environmental conditions, the northern fauna being the more truly marine, or to slight differences in stratigraphical position.

Table 1

Range table of Callovian to Tithonian Ostracoda from Tanzania

CALLOVIAN					OXFORDIAN				L. KIMMERIDGIAN				M. or Up KIMMERIDGIAN			TITHONIAN			STAGE
Mandawa Anticline			Wami River		Wami River				Mandawa Anticline										REGION
B 114	B 97	B 92	B 66	BM 94	B 2	BM 86	B 67	B 68	B 103a	B 104a	B 106a	B 107a	B 219	B 222	B 223	B 105b	B 110	B 111	SAMPLE
																	●	●	*Pirileberis*? sp.
			●														●	●	*Pireleberis prognata* Grekoff
																●	●	●	*Majungaella perforata* Grekoff
																●			*Cytherella* sp.
													●	●	●				*Majungaella praeperforata* Bate
									●				●	●	●				*Procytherura aerodynamica* Bate
						●		●				●	●		●				*Tricordis triangula* Bate
										●		●	●		●				*Cytheropteron aitkeni* Bate
													●		●				*Cytherella mandawaensis* Bata
													●		●				*Paracypris* sp. A
													●		●				*Monoceratina* sp. A
													●						*Mandelstamia* sp.
													●						*Bythocypris* sp. A
													●		●				*Mandelstamia grekoffi* Bate
													●		●				*Cytheropteron ndaui* Bate
															●				*Pleurocythere tanzanensis* Bate
													●		●				*Bairdia* sp. A
													●		●				*Pontocyprella* sp.
													●		●				*Rhadinocythere gracilis* Bate
													●		●				*Fastigatocythere* aff. *brentonensis* (Dingle)
													●		●				*Looneyella africana* Bate
													●		●				*Acrocythere*? *tricostata* Bate
													●		●				*Paracytherdea mandawaensis* Bate
													●		●				*Mandawacythere striata* Bate
															●				*Cytheropteron* sp.
												●	●						*Cytherelloidea* sp.
									●	●	●	●							*Galliaecytheridea manyuliensis* Bate
									●	●	●								*Majungaella kimmendgiana* Bate
					●			●											*Bairdia* sp. B
						●	●	●											*Cytherella umbilica* Bate
						●	●	●											*Bythocypris* sp. B
					●		●												*Majungaella oxfordiana* Bate
					●	●	●												*Cytheropteron grekoffi* Bate
				●	●														*Paracypris* sp. B
			●	●															*Cytherella masuguluensis* Bate
●	●	●																	*Cytherella knysnaensis* Dingle
●	●			●															*Amicythendea ihopyensis* (Grekoff)
			●																*Cytherella* cf. *collapsa* Grekoff
			●																*Paracypris* aff. *contermia* Ljubimova & Mohan
	●		●																*Majungaella mundula* (Grekoff)
			●																*Afrocytheridea laevigata* Bate
●																			*"Cytheretta"* sp.
●																			*Darwinula* sp.
●	●																		*Afrocytheridea faveolata* Bate
●	●																		*Bairdia* sp. C
●																			*Asciocythere*? sp.
	●																		*Procythendea disparlateralis* Bate
	●																		*Amicythendea triangulata* Bate
	●																		*Procytherura* sp.
	●																		*Monoceratina* sp. B
	●																		*Eucytherura* sp.
	●																		*Cytherelloidea brentonensis* Dingle

Upper Oxfordian fauna. *Majungaella oxfordiana* with *Paracypris* sp. B, *Cytheropteron grekoffi*, *Bythocypris* sp. B, *Cytherella umbilica*, *Bairdia* sp. B and *Trichordis triangula*. The richness of the Upper Oxfordian fauna is possibly limited by the arenaceous facies which has tended to facilitate removal of the microfossils by solution. The size of the fauna is not considered to be a true reflection on the size of the living ostracod populations.

Lower Kimmeridgian fauna. *Majungaella kimmeridgiana* with *Procytherura aerodynamica*, *Cytheropteron* (? *Infracytheropteron*) *aitkeni*, *Trichordis triangula*, *Galliaecytheridea manyuliensis* and *Cytherelloidea* sp. Again a rather poor fauna in terms of number of species but excessively rich in number of individuals. The three dominant species are *Majungaella kimmeridgiana*, *Galliaecytheridea manyuliensis* and *Procytherura aerodynamica*.

Possible reasons for the reduction in the number of species accompanied by an increase in the number of individuals cannot be the same as given for the reduced Oxfordian fauna. A reduction in the number of species is often associated with a change in the salinity from normal marine to either euryhaline or to hyperhaline conditions. In both cases a numerical increase in the number of individuals often follows. The presence of ammonites in the succession, however, suggests that normal marine conditions prevailed. Perhaps the reason for the reduced fauna lies in a lowering of the water temperature, but it is not possible on the evidence available to be more conclusive on this matter at the present time.

Middle or Upper Kimmeridgian fauna. *Majungaella praeperforata* with *Procytherura aerodynamica*, *Trichordis triangula*, *Cytheropteron* (? *Infracytheropteron*) *aitkeni*, *Cytheropteron* (*I.*) *ndaui*, *Cytheropteron* sp., *Cytherella mandawaensis*, *Cytherelloidea* sp., *Paracypris* sp. A, *Monoceratina* sp. A, *Mandelstamia* sp., *Mandelstamia grekoffi*, *Bythocypris* sp. A, *Pleurocythere tanzanensis*, *Bairdia* sp. A, *Pontocyprella* sp., *Rhadinocythere gracilis*, *Fastigatocythere* aff. *brentonensis*, *Looneyella africana*, *Acrocythere* ? *tricostata*, *Paracytheridea mandawaensis* and *Mandawacythere striata*. This is a typical marine continental shelf fauna rich in both species and in individuals. The presence of *Procytherura aerodynamica* sp. nov. off Western Australia (as Indet. sp. E of Oertli 1974), indicates that a stratigraphical correlation between East Africa and Australia should be possible.

Tithonian fauna. *Majungaella perforata* with *Pirileberis prognata*, *Pirileberis* ? sp. and *Cytherella* sp. Although the Tithonian samples may be subdivided into (?) Lower Tithonian (sample B105b) and Upper Tithonian (samples B110 and B111) the fauna is so small that it is preferable to consider it as a single assemblage. Preservation is not good and, as in the Oxfordian, extensive decalcification has taken place.

Only one ostracod genus, *Majungaella*, stands out as a useful marker fossil, the five species of which each characterize a broad stratigraphical unit. As such they are of considerable importance in correlating the Jurassic of East Africa with that of India and Madagascar – although all five species have not yet been identified from all three regions. Nevertheless the fact that the earliest and the last species

of the five are known from all three regions points to the likelihood that the presence of the other three may be discovered eventually.

The majority of the species described from Tanzania have a restricted vertical range and fall conveniently into five faunal assemblages. Of the 52 species recorded only six, *Cytherelloidea* sp., *Cytheropteron* (?*I.*) *aitkeni* Bate, *Pirileberis prognata* Grekoff, *Trichordis triangula* Bate and *Procytherura aerodynamica* Bate, occur in more than one faunal assemblage.

V. CORRELATION

Because of the paucity of exposures within Tanzania the sequence of Callovian to Tithonian has only been observed in relatively few outcrops and thus correlation between different sections has generally not been possible. The Middle Callovian (*anceps* Zone) is the only unit found in both the Wami River Area and the Mandawa Anticline that has yielded a microfossil assemblage. The Oxfordian of the Mandawa Anticline proved to be barren and the Kimmeridgian–Tithonian is not present in the Wami River Area.

Although the Middle Callovian fauna from the Mandawa Anticline differs from that of the Wami River, for reasons already discussed (p. 214), the presence of *Majungaella mundula* (Grekoff) and *Amicytheridea ihopyensis* (Grekoff) in both provides some means of correlation.

Fifty-two ostracod species are recorded here from the Callovian to Tithonian of Tanzania and this compares with the 49 species described by Grekoff (1963) from the Bajocian to Valanginian of Madagascar. Guha (1975 ?) records 40 species from the Bathonian to Valanginian of Kutch, and Dingle (1972) describes eight species from sediments considered to be Callovian from South Africa. This is the total available information at the present time on the Jurassic ostracod fauna of the countries bordering the Indian Ocean.

Correlation between the Middle Callovian of Tanzania and the supposed Callovian of South Africa is rather tenuous, only two species being common to both regions, *Cytherella knysnaensis* Dingle and *Cytherelloidea brentonensis* Dingle. One species, *Fastigatocythere* aff. *brentonensis* Dingle, has affinities with the species of that name from South Africa but the absence from the South African Callovian of a species of *Majungaella* makes a precise correlation impossible.

Eight species are common to Tanzania and Madagascar as follows. Callovian, *Amicytheridea ihopyensis* (Grekoff), *Majungaella mundula* (Grekoff) and *Afrocytheridea faveolata* Bate. Middle or Upper Kimmeridgian, *Amicytheridea triangulata* Bate and *Mandawacythere striata* Bate. Tithonian, *Pirileberis prognata* Grekoff and *Majungaella perforata* Grekoff. *Cytheropteron grekoffi* Bate (= *Cytheropteron* 1040 of Grekoff) is found in the Oxfordian of Tanzania and in the Kimmeridgian to Portlandian of Madagascar.

Five ostracods are common to Tanzania and Kutch. Callovian, *Amicytheridea ihopyensis* (Grekoff) and *Majungaella mundula* (Grekoff). Middle or Upper Kimmeridgian, *Mandawacythere striata* Bate. Tithonian, *Pirileberis prognata* Grekoff and *Majungaella perforata* Grekoff.

A much larger number of ostracods (14 species) is common to Kutch and Madagascar, which might indicate a closer relationship between these two countries than exists between either and Tanzania. More probably the difference is the result of incomplete sampling and of weathering. It is expected that future studies will confirm this by increasing the number of known ostracod species common to all three countries. East to the West Australian continental shelf, core 30 of site 263 (Oertli 1974) has revealed the presence of *Procytherura aerodynamica* (as Indet. sp. E). This suggests that a stratigraphical correlation for the Jurassic between East Africa and Western Australia will be possible.

VI. CONCLUSIONS

The Callovian to Tithonian sediments examined in this study represent a marine, shallow water continental shelf environment. The closeness of land nearby is confirmed at one horizon in the Middle Callovian of the Mandawa Anticline by the presence, within the microfossil assemblage, of charophytes and freshwater ostracods.

Five ostracod faunal assemblages, each characterized by a species of *Majungaella*, have been recognized. Although the importance of *Majungaella* species has not been fully tested, the evidence so far – the occurrence of *M. mundula* (Grekoff) in both north and south Tanzania, India and Madagascar and of *M. perforata* Grekoff in Tanzania, India and Madagascar – already indicates the value of this genus in regional correlation. The faunal assemblages themselves have not yet been used in correlation but the potential exists, with more detailed sampling, for a more precise comparison of the Jurassic not only of East Africa, Madagascar and India, but between all countries bordering the Indian Ocean having marine Jurassic sediments.

The Jurassic ostracods of Tanzania, Madagascar and India represent what is termed here a 'southern fauna', although perhaps a more precise term would be that of a 'south of the Tethys' fauna. The northern hemisphere position of India today is anomalous ; we must take into account that it was located further south during Jurassic times when the regions of deposition were very much closer than they are at the present day.

Although many genera of the southern fauna have a cosmopolitan distribution (e.g. *Cytherella, Cytherelloidea, Bairdia, Cytheropteron* and *Paracypris*), many are known only from the area south of the Tethys (*Majungaella, Trichordis, Amicytheridea, Pirileberis, Afrocytheridea, Rhadinocythere* and *Mandawacythere*). Of these, *Majungaella* is of interest because of its phylogenetic relationship to the northern genus *Progonocythere* Sylvester-Bradley 1948, which, apart from one known species (*P. laeviscula* Ljubimova & Mohan 1960), it replaces completely in the Jurassic succession.

One ostracod, *Pleurocythere tanzanensis* Bate, although considered to belong to the northern genus *Pleurocythere*, has significant morphological differences that establish it as a southern form which has undergone evolutionary change since its migration south.

VII. ACKNOWLEDGEMENTS

Without the generous assistance of the Geological Survey of Tanzania and in particular the acting Director, Mr A. C. M. McKinlay, the expedition to Tanzania would not have been possible. It is, therefore, with considerable pleasure that I record here my thanks to all concerned. My colleagues, Dr Noel Morris and Dr Michael Howarth, assisted both in the field and in dating the samples. To both I extend my sincere thanks. Dr D. K. Guha very kindly made available photographs and material from his paper on the Jurassic ostracods of Kutch which proved to be invaluable in this research. Thanks are also due to Mrs Carol Mayes who drew the maps for this paper.

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IX. INDEX

New taxonomic names and the page numbers of the principal references are printed in **bold** type. An asterisk (*) denotes a figure.

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PLATE 1

Cytherella knysnaensis Dingle (p. 172)
Middle Callovian, sample B97

FIG. 1. Left side, complete carapace, Io.6021, ×70.
FIG. 5. Dorsal view, complete carapace, Io.6022, ×70.

Cytherella masuguluensis sp. nov. (p. 173)
Middle Callovian, sample B66

FIG. 2. Left side, complete carapace, holotype, Io.6029, ×70.
FIG. 10. Dorsal view, complete carapace, paratype, Io.6030, ×70.

Cytherella mandawaensis sp. nov. (p. 172)
Middle or Upper Kimmeridgian

FIG. 3. Left side, complete carapace, holotype Io.6023, sample B223, ×70.
FIG. 4. Internal view, right valve, paratype Io.6027, sample B219, ×70.
FIG. 7. External view, right valve, paratype Io.6026, sample B219, ×70.
FIG. 8. External view, left valve, paratype Io.6025 sample B219, ×70.
FIG. 9. Dorsal view, complete carapace, paratype Io.6028, sample B223, ×70.

Cytherella sp. (p. 174)

FIG. 6. (?) Lower Tithonian, sample B105b. External view, left valve, Io.6036, ×68.

Cytherella cf. ***collapsa*** Grekoff (p. 171)

FIG. 11. Middle Callovian, sample B66. External view, left valve, Io.5821, ×90.

Cytherella umbilica sp. nov. (p. 173)
Upper Oxfordian, sample B67.

FIG. 12. External view, left valve, paratype Io.6033 ×59.
FIG. 13. External view, right valve, holotype Io.6032 ×48.
FIG. 14. External view, right valve, paratype Io.6034 ×74.

Cytherelloidea sp. (p. 174)

FIG. 15. Lower Kimmeridgian, sample B107a. External view, left valve, Io.6039, ×70.

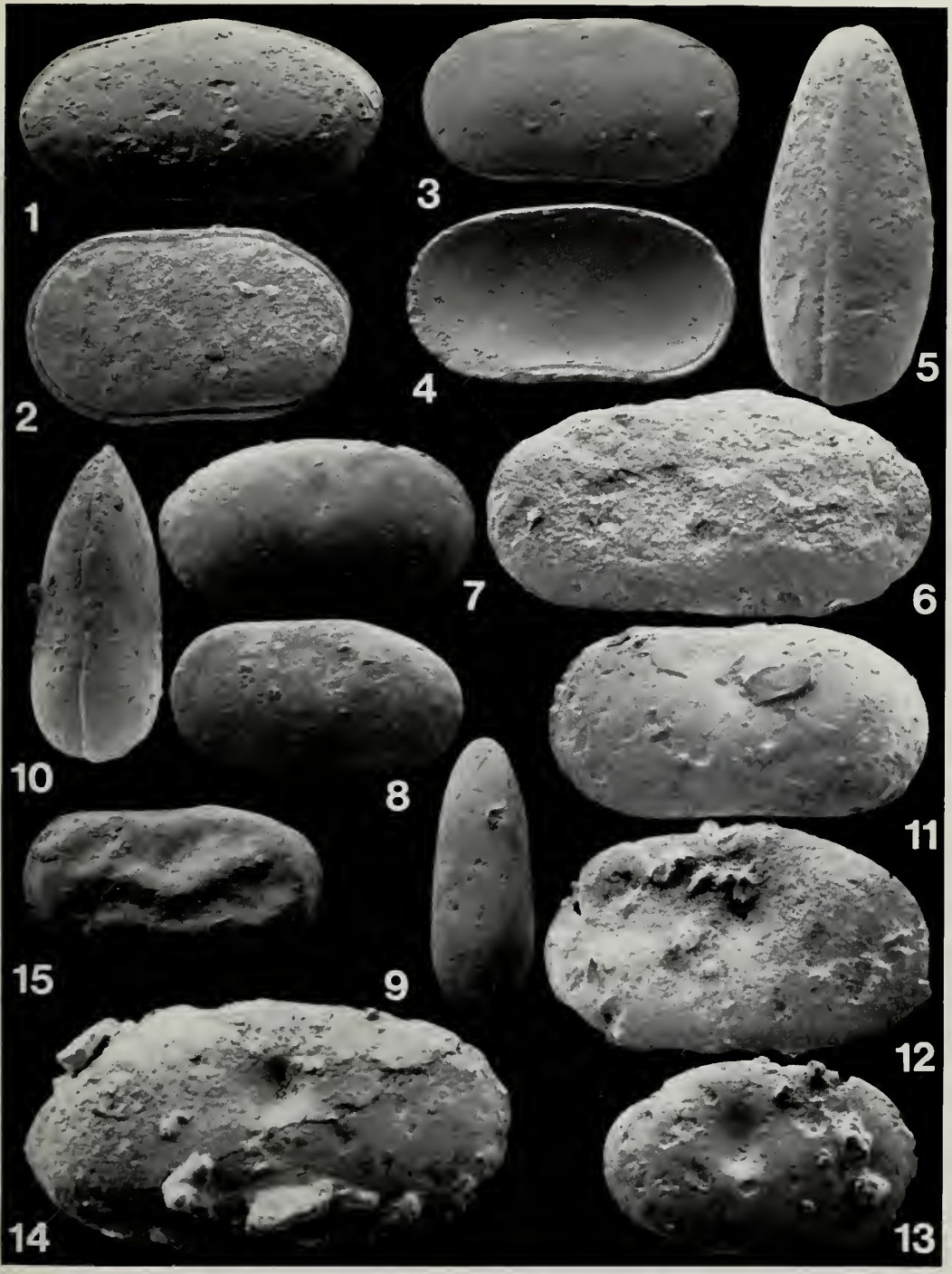
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PLATE 2

Cytherelloidea brentonensis Dingle (p. 174)

FIG. 1. Middle Callovian, sample B97. External view, left side, complete carapace, Io.6037, × 50.

Paracypris sp. B (p. 178)

FIG. 2. Middle Callovian, sample BM94. External view, left side, complete carapace, Io.6050, × 80.

Monoceratina sp. B (p. 180)

FIG. 3. Middle Callovian, sample B97. External view, left valve, Io.6059, × 100.

Paracypris sp. A (p. 178)

Middle or Upper Kimmeridgian, sample B223

FIG. 4. External view, left side, complete carapace, Io.6049, × 70.

FIG. 5. External view, right side, complete carapace, Io.6048, × 70.

Paracypris aff. ***P. contermia*** Ljubimova & Mohan (p. 177)

FIG. 6. Middle Callovian, sample B66. External view, right side, complete carapace, Io.6047, × 80.

Bythocypris sp. B (p. 177)

FIG. 7. Upper Oxfordian, sample B67. External view, right side, complete carapace, Io.6045, × 70.

Bythocypris sp. A (p. 176)

FIG. 8. Middle or Upper Kimmeridgian, sample B219. External view, left valve, Io.6044, × 70.

Bairdia sp. C (p. 175)

Middle Callovian

FIG. 9. External view, right side, juvenile carapace, Io.6043, sample B114, × 100.

FIG. 13. External view, right side, adult carapace, Io.6042, sample B97, × 90.

Monoceratina sp. A (p. 179)

Middle or Upper Kimmeridgian, sample B219

FIG. 10. External view, right side, complete carapace, Io.6057, × 70.

FIG. 11. External view, left side, complete carapace, Io.6058, × 70.

Darwinula sp. (p. 179)

FIG. 12. Middle Callovian, sample B114. External view, right side, complete carapace, Io.6056, × 70.

Bairdia sp. A (p. 175)

FIG. 14. Middle or Upper Kimmeridgian, sample B223. External view, right side, juvenile carapace, Io.6040, × 129.

Pontocyprella sp. (p. 178)

Middle or Upper Kimmeridgian, sample B223

FIG. 15. Internal view, right valve, Io.6054, × 120.

FIG. 16. External view, left valve, Io.6051, × 120.

FIG. 17. External view, right side, complete carapace, Io.6053, × 120.

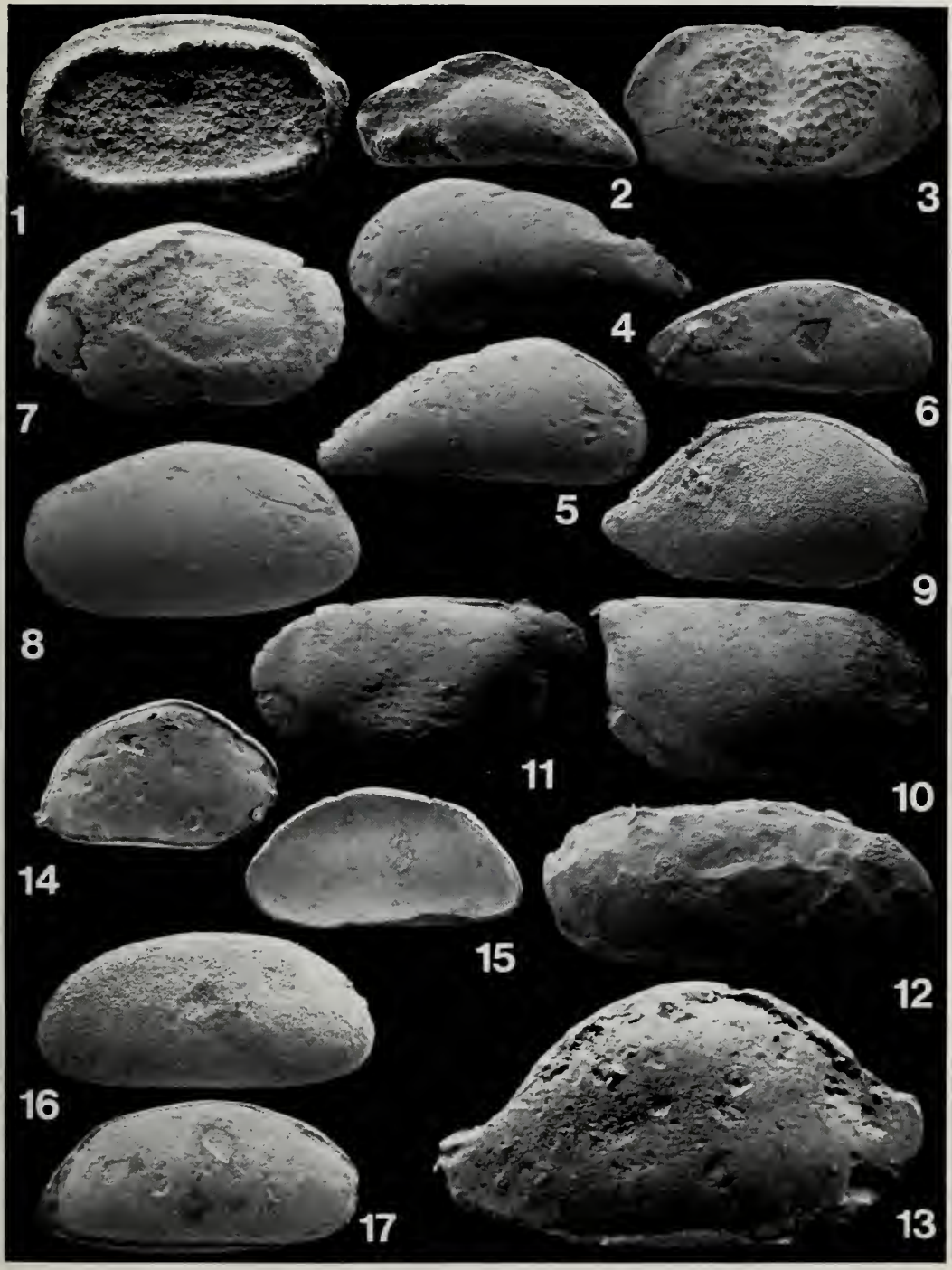
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PLATE 3

Majungaella perforata Grekoff (p. 181)

Tithonian

FIG. 1. External view, left side, male carapace, Io.6065, sample B111, ×80.

FIG. 2. External view, left side, female carapace, Io.6064, sample B111, ×80.

FIG. 3. External view, right side, male carapace, Io.6063, sample B110, ×80.

FIG. 7. Dorsal view, female carapace, Io.6062, sample B110, ×80.

Majungaella praeperforata sp. nov. (p. 182, see also Pl. 4, figs 1–3)

Middle or Upper Kimmeridgian, sample B219

FIG. 4. External view, female left valve, paratype Io.6067, ×70.

FIG. 5. External view, male left valve, paratype Io.6068, ×70.

FIG. 6. External view, right side, female carapace, holotype Io.6066, ×70.

FIG. 8. Internal view, female left valve, paratype Io.6072, ×70.

FIG. 9. Internal view, female right valve, paratype Io.6070, ×70.

FIG. 10. Anterior duplicature showing marginal pore canals, male right valve, paratype Io.6069, ×180.

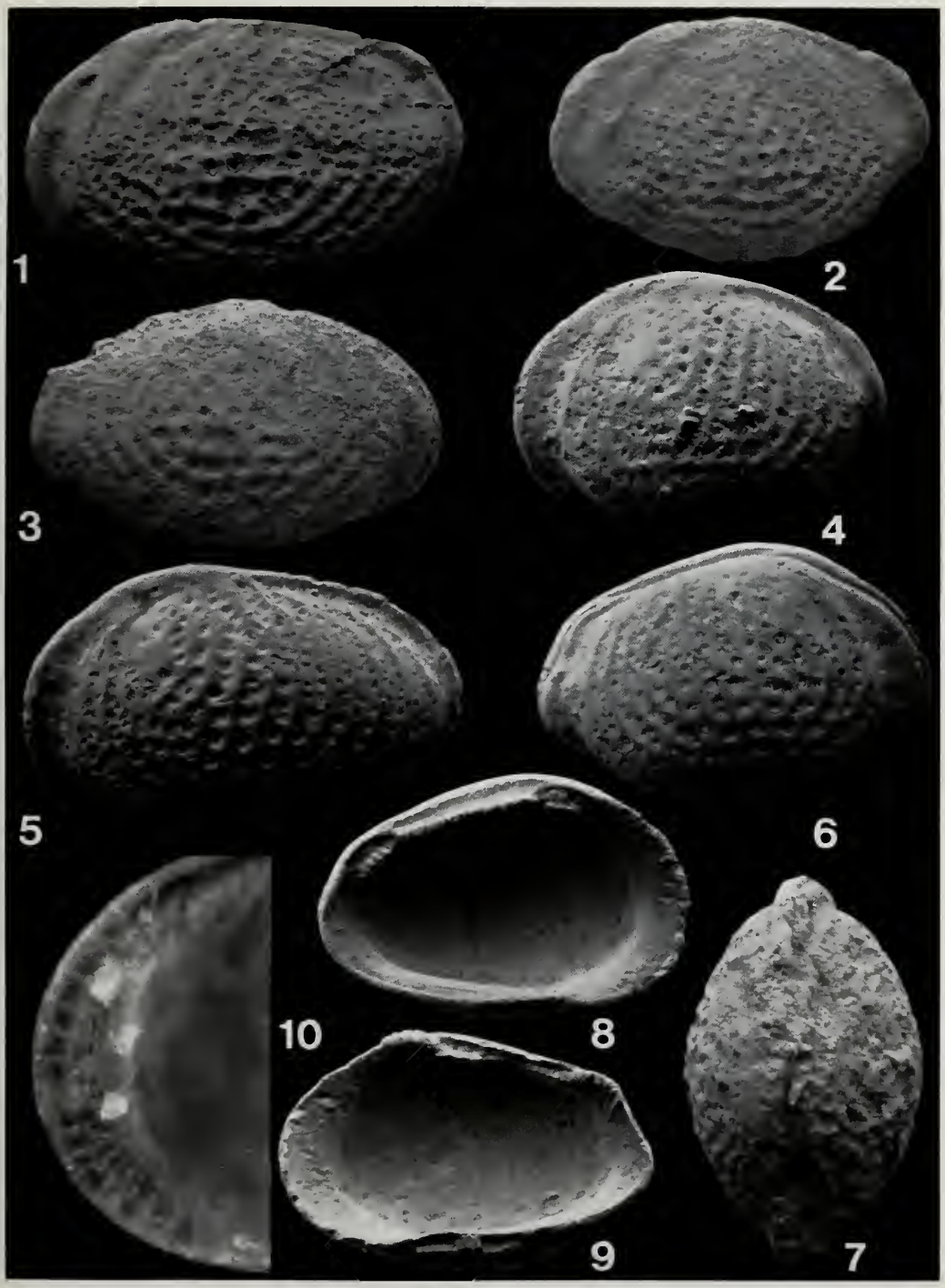
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PLATE 4

Majungaella praeperforata sp. nov. (p. 182, see also Pl. 3, figs 4–6, 8–10)
Middle or Upper Kimmeridgian, sample B219

FIG. 1. External view, male right valve, paratype Io.6073, ×70.
FIG. 2. Dorsal view, female carapace, paratype Io.6071, ×70.
FIG. 3. Ventral view, female carapace, paratype Io.6074, ×70.

Majungaella kimmeridgiana sp. nov. (p. 183, see also Pl. 5, figs 1–3)
Lower Kimmeridgian

FIG. 4. External view, right side, female carapace, holotype Io.6075, sample B103a, ×80.
FIG. 5. External view, left side, female carapace, paratype Io.6085, sample B103a, ×80.
FIG. 6. Ventral view, female carapace, paratype Io.6084, sample B103a, ×80.
FIG. 7. Dorsal view, male carapace, paratype Io.6081, sample B104a, ×80.
FIG. 8. Dorsal view, median hinge bar, female left valve, paratype Io.6080, sample B104a, ×250.
FIG. 9. Internal view, female left valve, paratype Io.6077, sample B103a, ×80.
FIG. 10. Dorsal view, female carapace, paratype Io.6086, sample B103a, ×80.
FIG. 11. Right valve hinge, female paratype Io.6078, sample B103a, ×170.

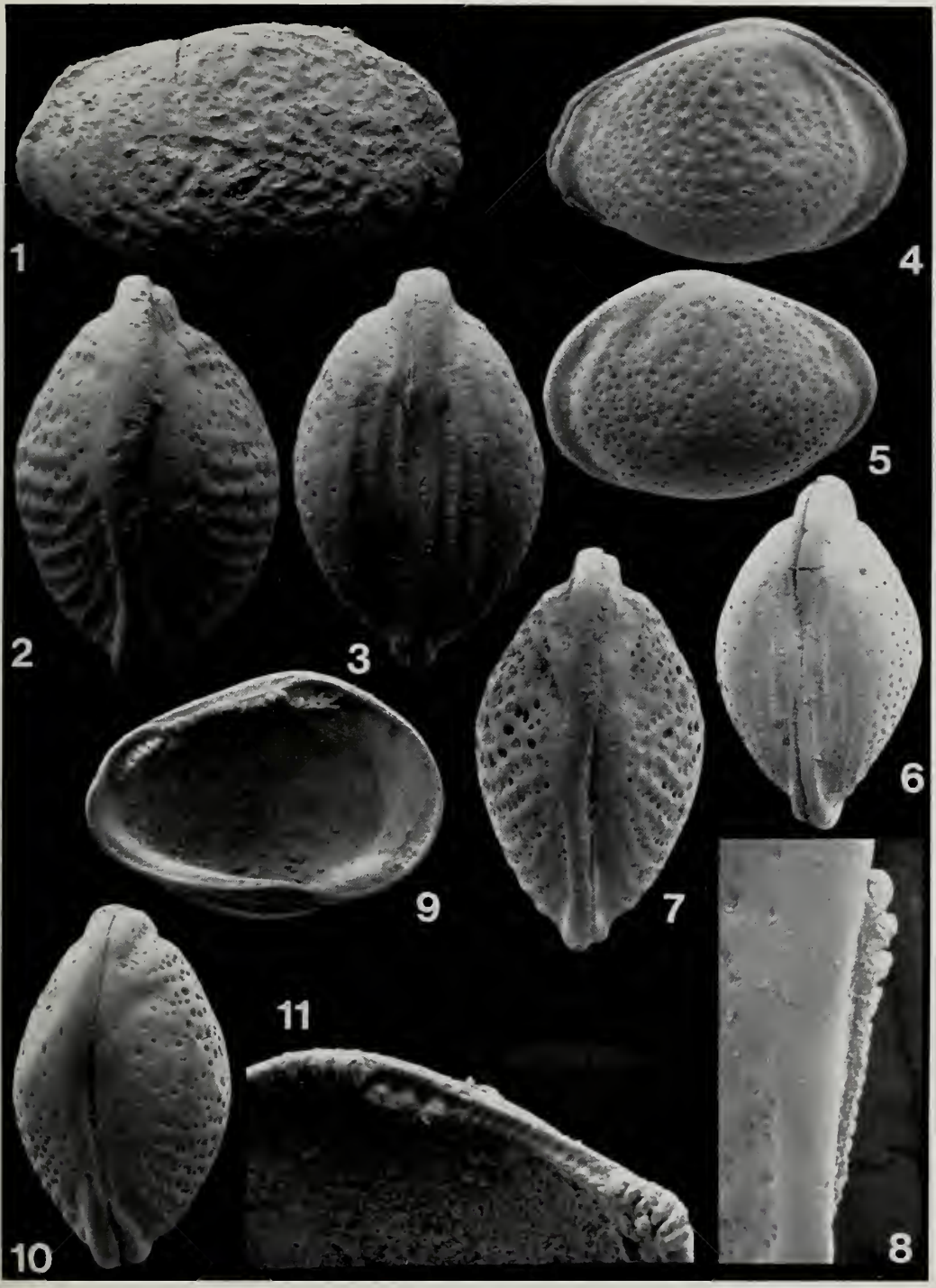
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PLATE 5

Majungaella kimmeridgiana sp. nov. (p. 183, see also Pl. 4, figs 4–11)
Lower Kimmeridgian

FIG. 1. External view, right side, male carapace, paratype Io.6076, sample B103a, ×80.
FIG. 2. External view, male left valve, paratype Io.6083, sample B103a, ×80.
FIG. 3. Ventral view, male carapace, paratype Io.6082, sample B104a, ×80.

Majungaella oxfordiana sp. nov. (p. 185)
Upper Oxfordian, sample B2

FIG. 4. External view, right side, male carapace, paratype Io.6089, ×80.
FIG. 5. External view, right side, female carapace, holotype Io.6088, ×80.
FIG. 6. Dorsal view, female carapace, paratype Io.6093, ×80.
FIG. 7. Internal view, female left valve, paratype Io.6092, ×80.
FIG. 8. Dorsal view to show median hinge element, female left valve, paratype Io.6090, ×80.
FIG. 9. External view, female right valve, paratype Io.6091, ×80.

Majungaella mundula (Grekoff) (p. 185)
Middle Callovian, sample B66

FIG. 10. External view, right side, complete carapace, Io.6096, ×90.
FIG. 11. Ventral view, complete carapace, Io.6098, ×90.
FIG. 12. External view, left side, complete carapace, Io.6095, ×90.
FIG. 13. Dorsal view, complete carapace, Io.6097, ×90.

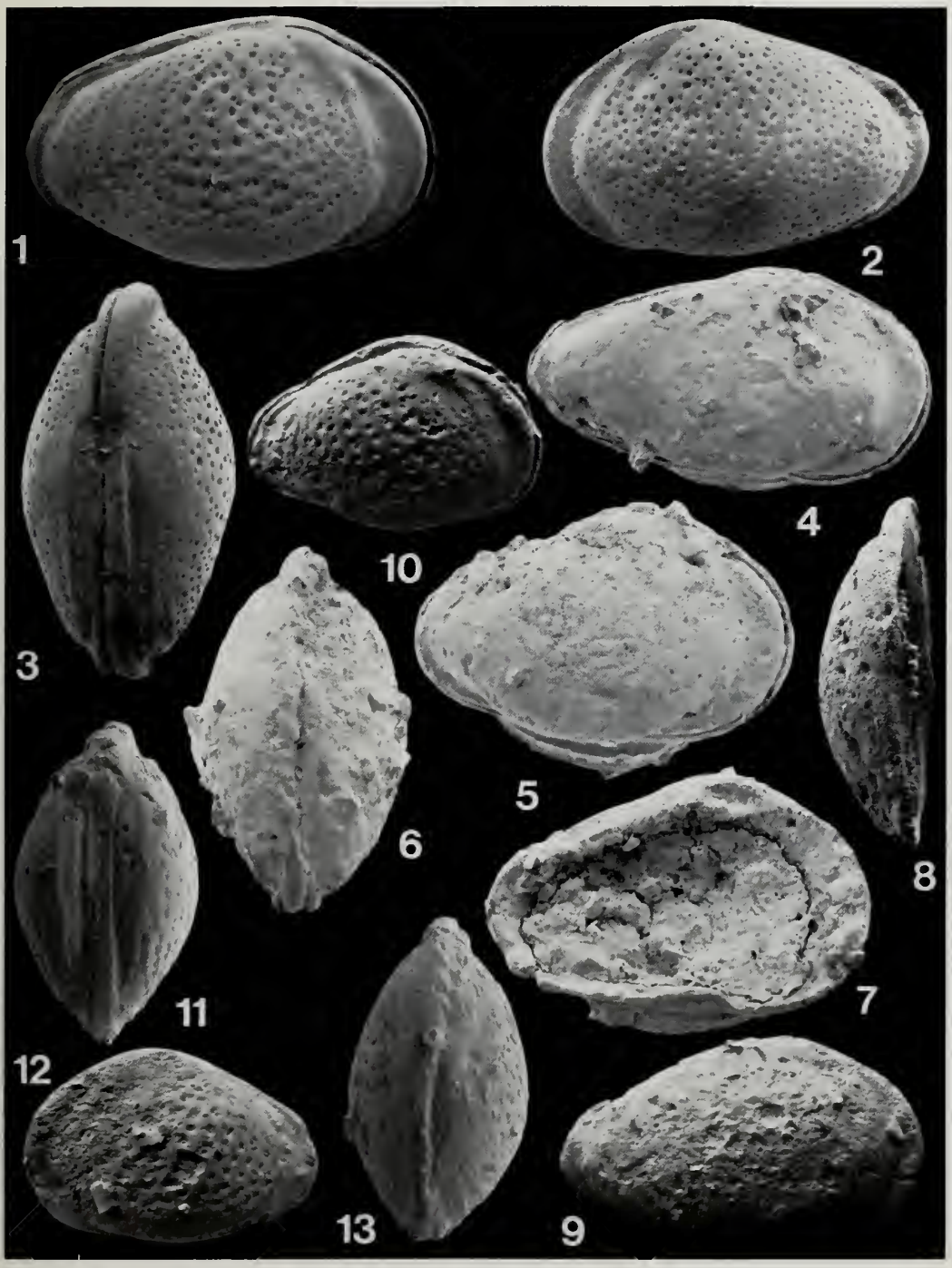
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PLATE 6

Trichordis triangula sp. nov. (p. 187)
Oxfordian, Lower and Middle or Upper Kimmeridgian

FIGS 1, 5. Right side and ventral view, female carapace, holotype Io.6105, sample B219, × 100.

FIG. 2. Internal view, female left valve, paratype Io.6110, sample B219, × 100.

FIG. 3. External view, female left valve, paratype Io.6109, sample B219, × 100.

FIG. 4. External view, male left valve, paratype Io.6107, sample B107a, × 100.

FIG. 6. Dorsal view, female carapace, paratype Io.6108, sample B219, × 100.

FIG. 7. External view, female left valve, paratype Io.6106, sample BM86, × 100.

FIG. 8. Adductor and frontal muscle scars (anterior to right), female left valve, paratype Io.6110, sample B219, × 850.

FIG. 14. Internal view, male right valve, paratype Io.6111, sample B223, × 165.

Fastigatocythere aff. ***brentonensis*** (Dingle) (p. 186, see also Pl. 7, fig. 9)
Middle or Upper Kimmeridgian, sample B223

FIG. 9. External view, left valve showing oblique ribbing, Io.6102, × 120.

FIG. 10. External view of left valve showing absence of oblique lateral ribbing, Io.6104, × 120.

Pleurocythere tanzanensis sp. nov. (p. 189)
Middle or Upper Kimmeridgian, sample B223

FIGS 11, 12. External views, right and left, complete carapace, holotype Io.6137, × 100.

FIG. 13. External view, broken left valve, paratype Io.6138, × 100.

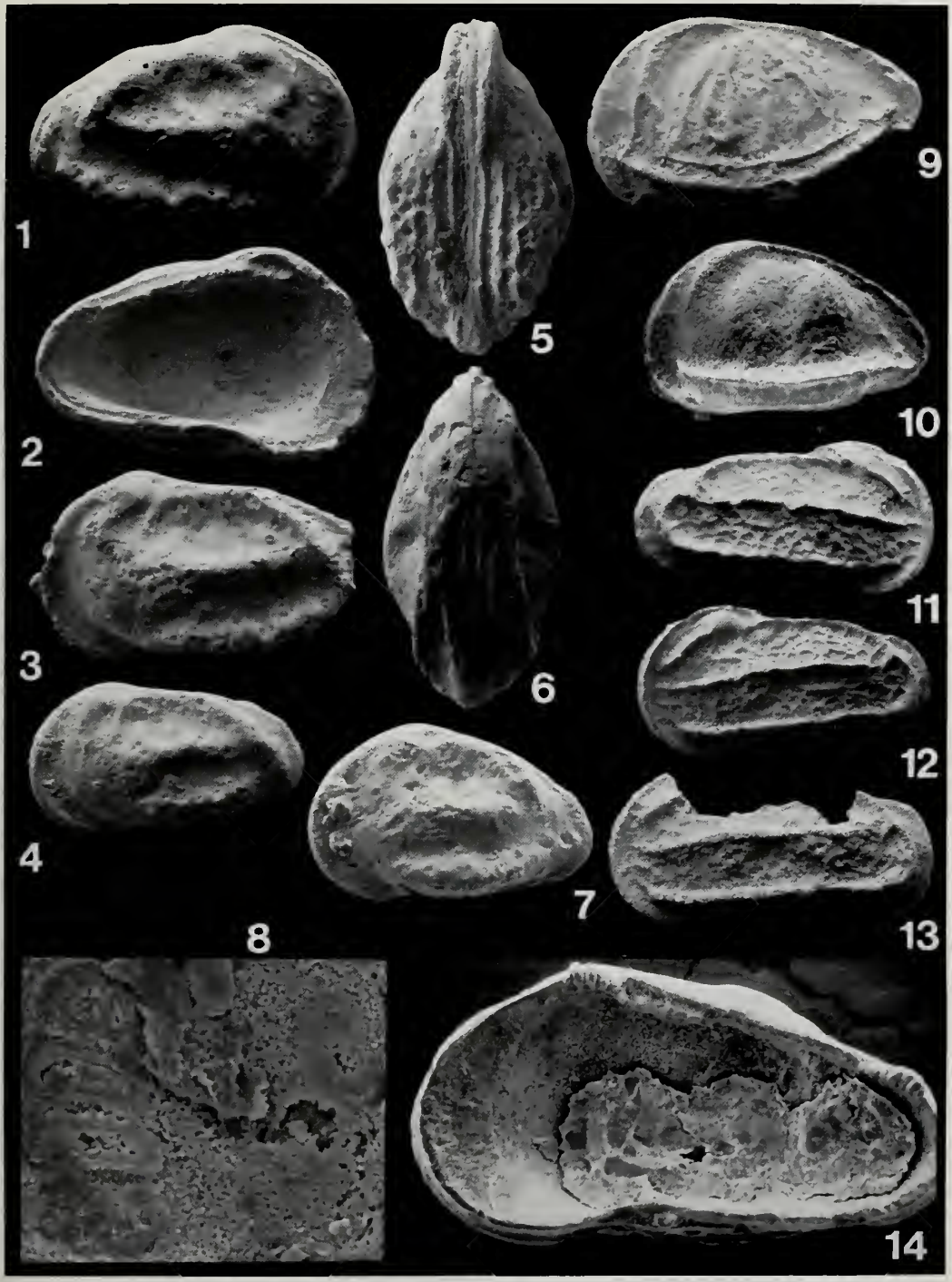
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PLATE 7

Mandelstamia grekoffi sp. nov. (p. 188)
Middle or Upper Kimmeridgian

FIG. 1. Dorsal view, complete carapace, paratype Io.6171, sample B223, ×100.
FIG. 2. External view, complete carapace, paratype Io.6169, sample B219, ×100.
FIG. 3. External view, left valve, paratype Io.6168, sample B219, ×100.
FIG. 4. External view, right valve, holotype Io.6172, sample B219, ×100.
FIGS 5, 6. Internal view, ×100 and enlarged view of posterior hinge element, ×290, right valve, paratype Io.6170, sample B223.

Mandelstamia sp. (p. 189)
Middle or Upper Kimmeridgian, sample B223

FIG. 7. External view, left side, complete carapace, Io.6166, ×100.
FIG. 8. External view, right valve, Io.6165, ×100.

Fastigatocythere aff. ***brentonensis*** (Dingle) (p. 186, see also Pl. 6, figs 9–10)
FIG. 9. Middle or Upper Kimmeridgian, sample B223. Dorsal view, left valve, Io.6103, ×120.

Amicytheridea ihopyensis (Grekoff) (p. 191)
Middle Callovian

FIG. 10. Internal view, female left valve, Io. 6117, sample B97, ×90.
FIG. 11. External view, right side, female carapace, Io.6251, sample B97, ×90.
FIG. 12. External view, female carapace, Io.6118, sample BM94, ×90.
FIG. 13. Dorsal view, female carapace, Io.6119, sample B97, ×90.

Amicytheridea triangulata sp. nov. (p. 192)
Middle Callovian, sample B97

FIGS 14, 15. Dorsal and right views, male carapace, paratype Io.6113, ×80.
FIG. 16. External view, female left valve, holotype Io.6114, ×80.

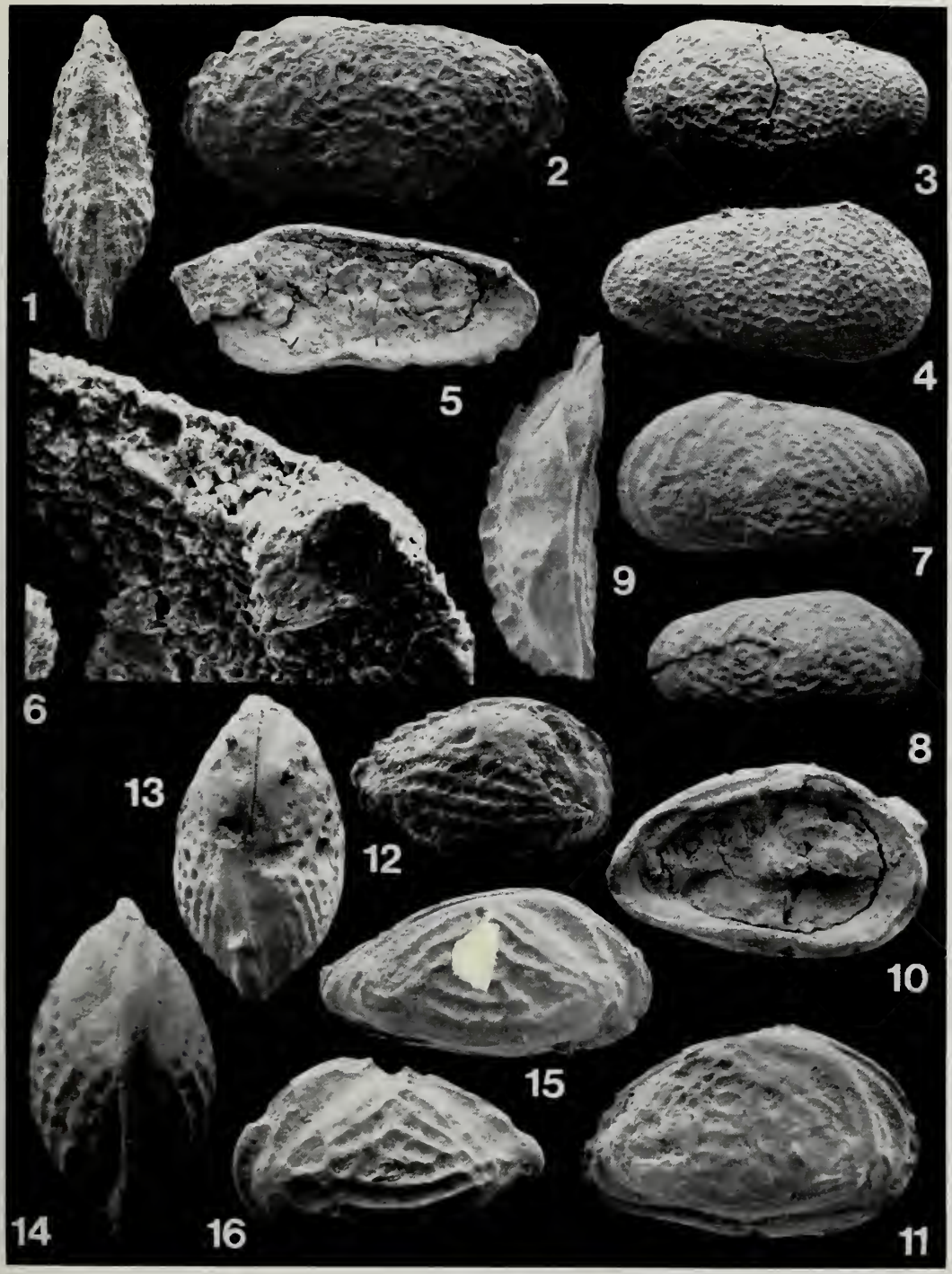
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PLATE 8

Asciocythere ? sp. (p. 193)
Middle Callovian, sample B114

FIG. 1. External view, left side, complete carapace, Io.6253, ×150.
FIG. 2. External view, right side, complete carapace, Io.6252, ×150.

Pirileberis ? sp. (p. 194)
Tithonian

FIG. 3. Dorsal view, complete carapace, Io.6162, sample B110, ×90.
FIG. 4. Internal view, left valve, Io.6159, sample B110, ×90.
FIG. 5. External view, left side, complete carapace, Io.6160, sample B111, ×90.
FIG. 6. External view, right side, complete carapace, Io.6158, sample B111, ×90.

Procytheridea disparlateralis sp. nov. (p. 199)
Middle Callovian, sample B97

FIG. 7. External view, left side, complete carapace, holotype Io.6135, ×120.
FIG. 8. External view, right side, complete carapace, paratype Io.6134, ×120.

Pirileberis prognata Grekoff (p. 194)
Middle Callovian and Middle or Upper Kimmeridgian

FIG. 9. External view, left side, female carapace, Io.6164, sample B66, ×80.
FIG. 10. External view, right side, male carapace, Io.6154, sample B111, ×70.
FIG. 11. External view, left side, male carapace, Io.6163, sample B66, ×80.

Afrocytheridea faveolata sp. nov. (p. 196)
Middle Callovian, sample B97

FIG. 12. External view, female right valve, holotype Io.6132, ×70.
FIG. 13. External view, male right valve, paratype Io.6128, ×70.

Afrocytheridea laevigata sp. nov. (p. 195, see also Pl. 9, figs 1–4)

FIG. 14. Middle Callovian, sample B66. External view, right side, male carapace, paratype Io.6125, ×70.

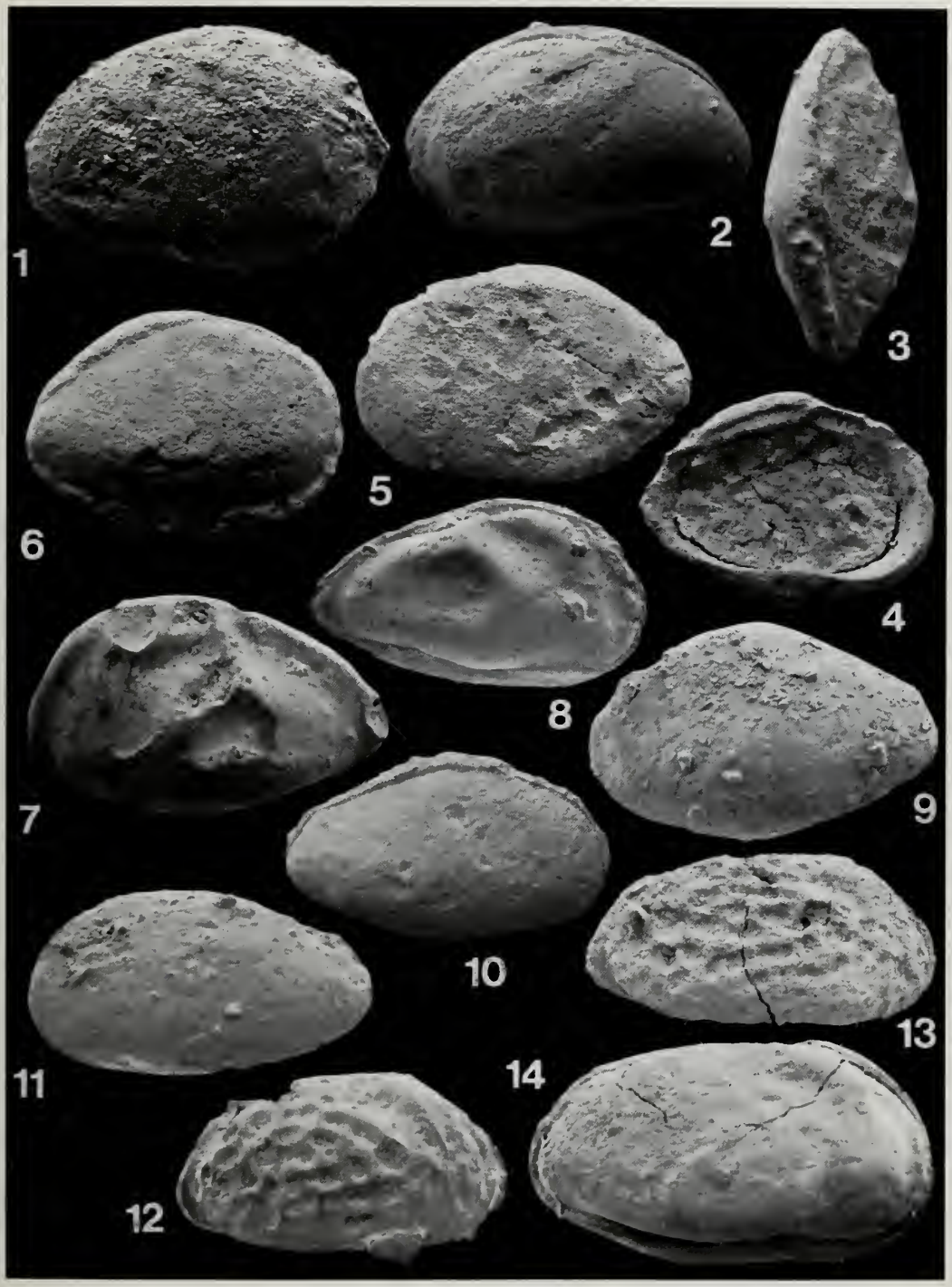
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PLATE 9

Afrocytheridea laevigata sp. nov. (p. 195, see also Pl. 8, fig. 14)
Middle Callovian, sample B66

FIG. 1. External view, left side, female carapace, paratype Io.6123, ×70.

FIG. 2. External view, left side, male carapace, Io.6124, ×70.

FIG. 3. External view, right side, female carapace, Io.6122, ×70.

FIG. 4. Dorsal view, female carapace, paratype Io.6127, ×70.

Galliaecytheridea manyuliensis sp. nov. (p. 197)
Lower Kimmeridgian, sample B107a

FIG. 5. External view, female right valve showing marginal denticles, holotype Io.6141, ×80.

FIG. 6. External view, male left valve, paratype Io.6148, ×80.

FIGS 7, 13. Internal view, ×80 and enlargement of hinge, ×200, female right valve, paratype Io.6143.

FIG. 8. External view, female left valve, paratype Io.6147, ×80.

FIG. 9. External view, male right valve, paratype Io.6146, ×80.

FIG. 10. Dorsal view to show terminal hinge teeth, female right valve, paratype Io.6144, ×80.

FIGS 11, 14. Enlargement of hinge, ×175, and of muscle scars (anterior to right), ×400, male left valve, paratype Io.6145.

FIG. 12. Enlargement of hinge, female left valve, paratype Io.6142, ×160.

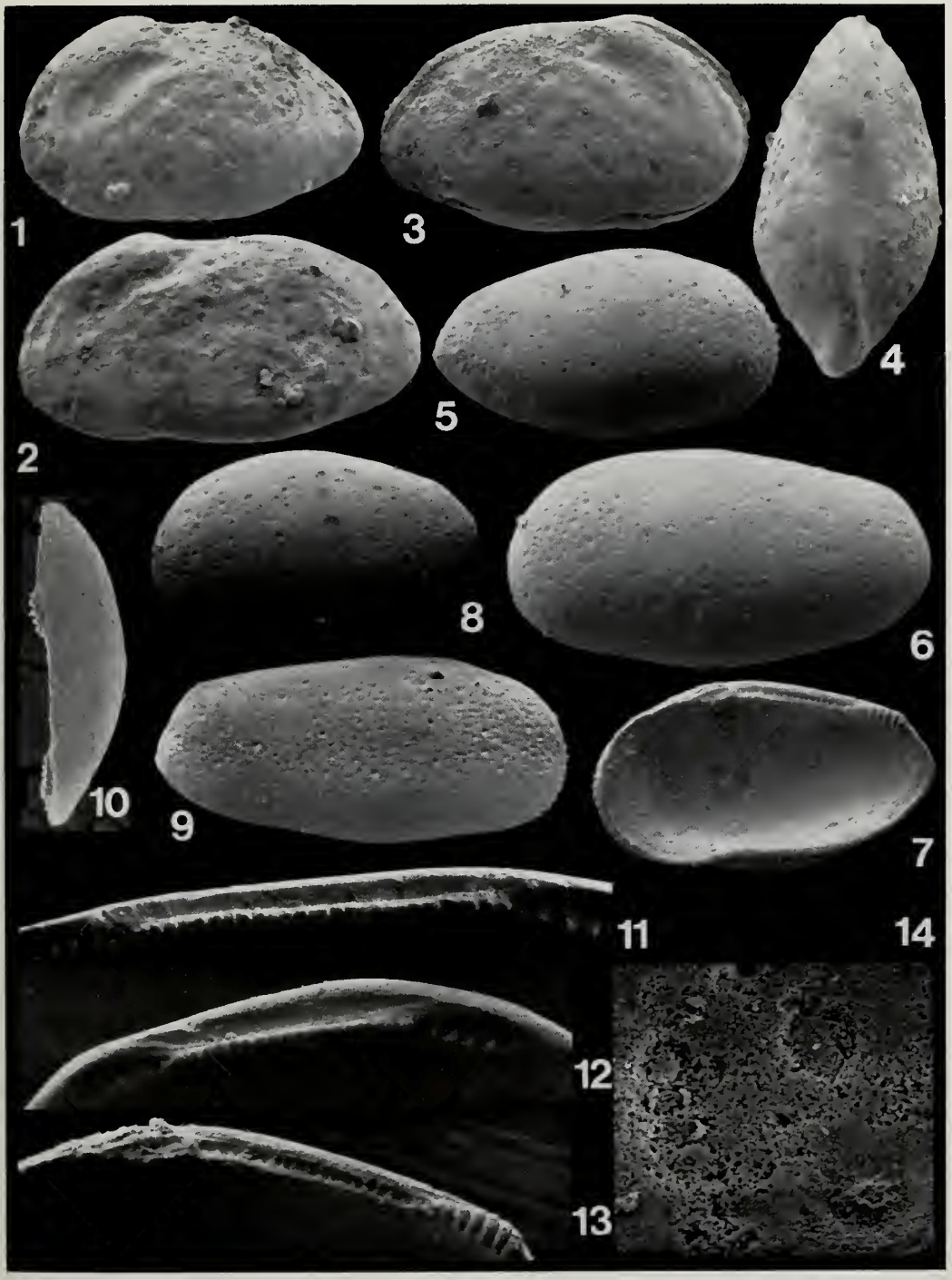
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PLATE 10

'Cytheretta' sp. (p. 200)

FIGS 1, 2. Middle Callovian, sample B114. External views, left and right of complete carapace, Io.6173, ×100.

Mandawacythere striata sp. nov. (p. 201)

Middle or Upper Kimmeridgian

FIGS 3, 4, 10. External and internal views ×150 and muscle scars (anterior to right), ×980, female right valve, holotype Io.6174, sample B219.

FIG. 5. Dorsal view, female carapace, paratype Io.6177, sample B223, ×150.

FIG. 6. Ventral view, female carapace, paratype Io.6178, sample B223, ×150.

FIG. 7. External view, juvenile right valve, paratype Io.6176, sample B223, ×150.

FIGS 8, 9. Internal and external views, male right valve, paratype Io.6175, sample B219, ×150.

Rhadinocythere gracilis sp. nov. (p. 202, see also Pl. 11, figs 1–4)

Middle or Upper Kimmeridgian, sample B223

FIG. 11. External view, right side, complete carapace, paratype Io.6184, ×140.

FIG. 12. Internal view, left valve, paratype Io.6186, ×140.

FIG. 13. Internal view, right valve, paratype Io.6185, ×140.

FIG. 14. External view, right side, complete carapace, holotype Io.6182, ×140.

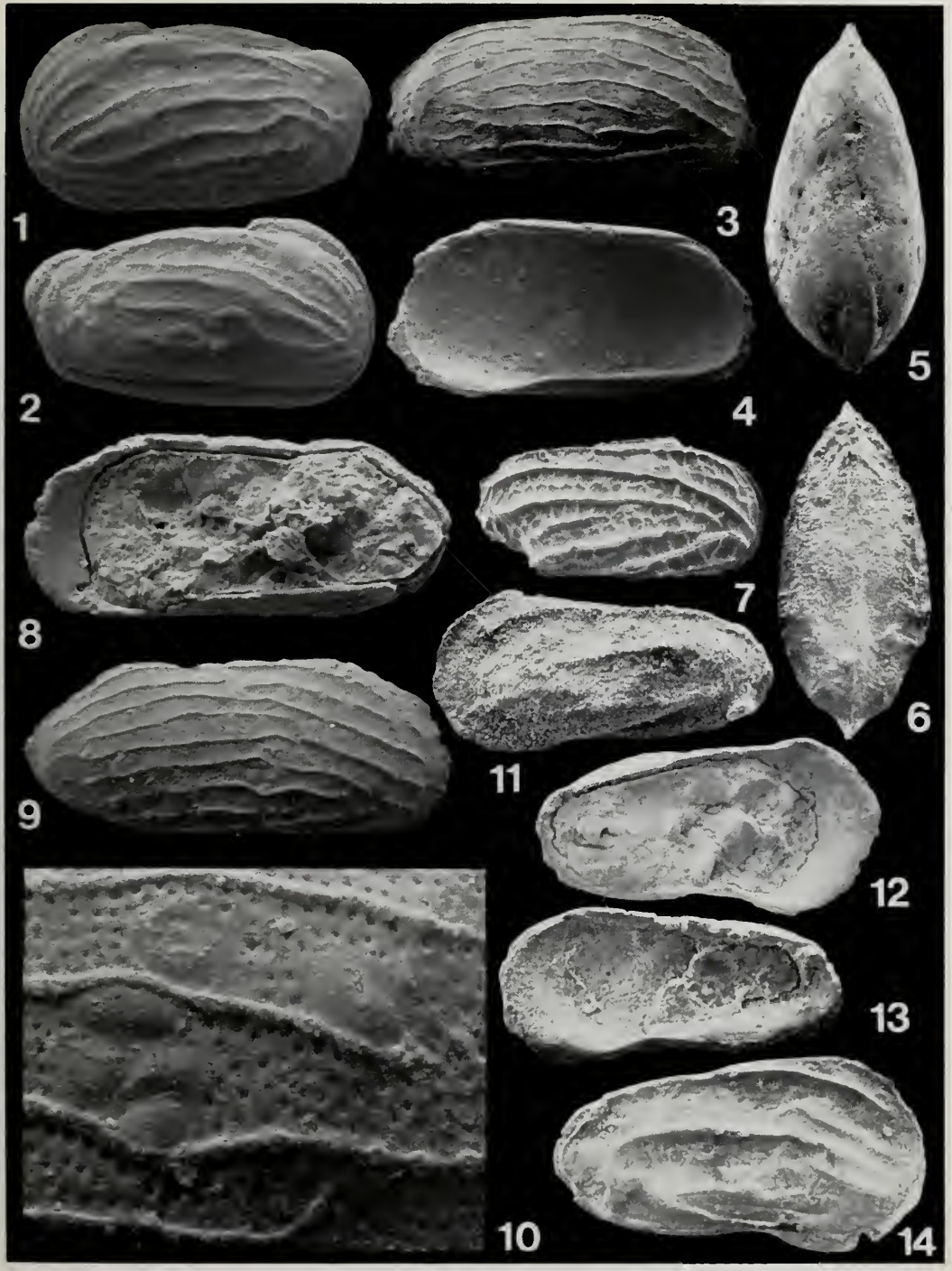
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PLATE 11

Rhadinocythere gracilis sp. nov. (p. 202, see also Pl. 10, figs 11–14)
Middle or Upper Kimmeridgian, sample B223

FIGS 1, 2. Anterior and posterior hinge teeth, right valve, paratype Io.6185, ×1000.

FIGS 3, 4. Dorsal views showing variation in surface ornamentation, paratypes Io.6187 and Io.6183, ×140.

Eucytherura sp. (p. 204)

FIGS 5, 6. Middle Callovian, sample B97. External and internal views, left valve, Io.6190, ×140.

Procytherura aerodynamica sp. nov. (p. 204, see also Pl. 12, figs 1–3)
Middle or Upper Kimmeridgian, sample B219

FIG. 7. External view, right side, male carapace, holotype Io.6191, ×100.

FIG. 8. External view, left side, female carapace, paratype Io.6192, ×100.

FIG. 9. Internal view, juvenile right valve, paratype Io.6199, ×100.

FIGS 10, 16. External view, ×100 and enlargement of surface to show pitting, ×500, juvenile right valve, paratype Io.6200.

FIG. 11. External view, juvenile left valve, paratype Io.6203, ×100.

FIG. 12. External view, male right valve, paratype Io.6202, ×100.

FIG. 13. External view, female right valve, paratype Io.6193, ×100.

FIG. 14. Internal view, male left valve, paratype Io.6197, ×100.

FIG. 15. Internal view, female right valve, paratype Io.6196, ×100.

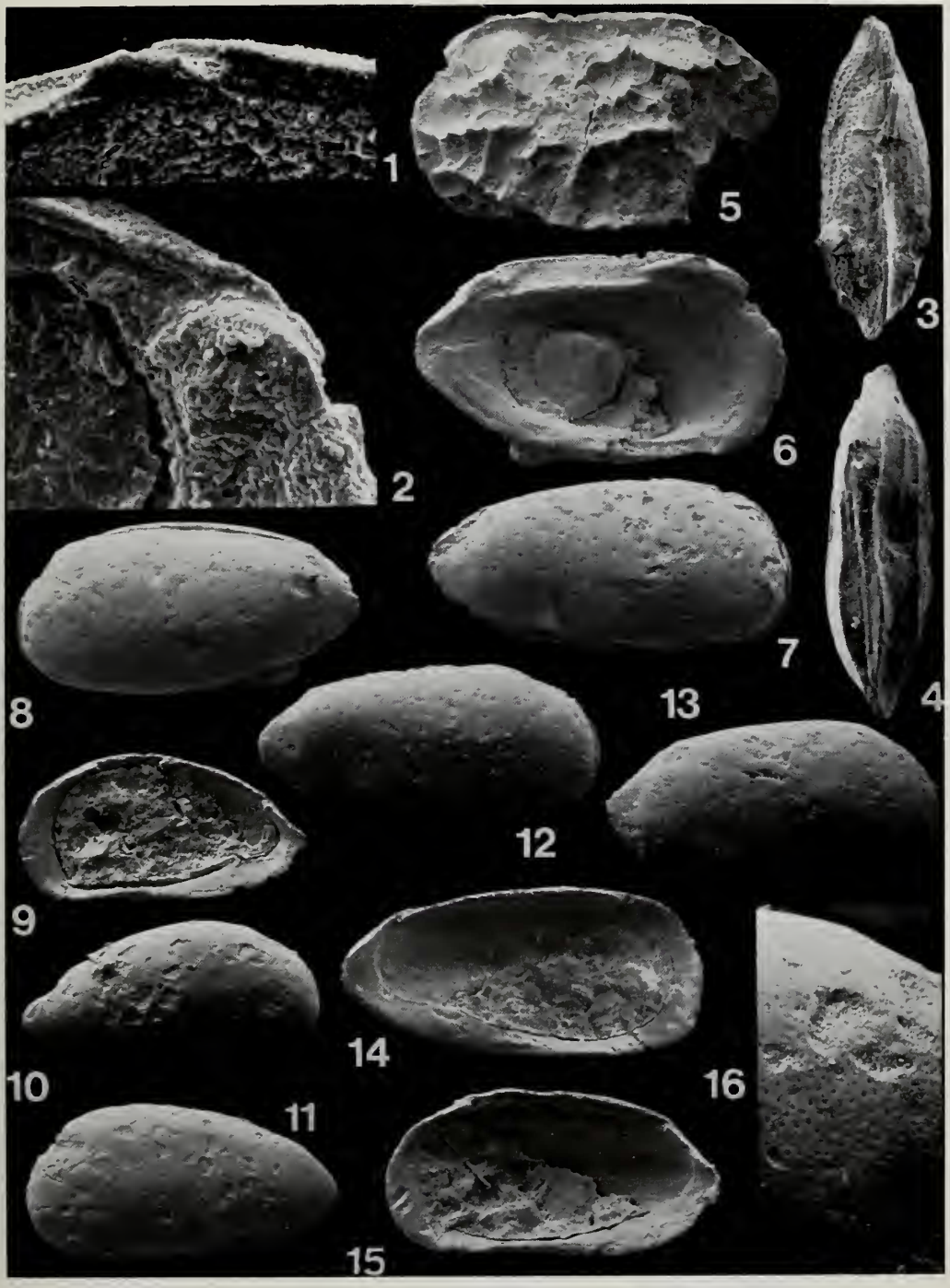
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PLATE 12

Procytherura aerodynamica sp. nov. (p. 204, see also Pl. 11, figs 7–16)
Middle or Upper Kimmeridgian, sample B219

FIG. 1. Enlargement of posterior hinge socket, female left valve, paratype Io.6198, ×500.
FIG. 2. Ventral view, male carapace, paratype Io.6194, ×100.
FIG. 3. Dorsal view, juvenile carapace, paratype Io.6195, ×100.

Procytherura sp. (p. 206)

FIG. 4. Middle Callovian, sample B97. Right side, complete carapace, Io.6209, ×150.

Cytheropteron (? Infracytheropteron) aitkeni sp. nov. (p. 206)
Lower and Middle or Upper Kimmeridgian

FIG. 5. External view, juvenile left valve, paratype Io.6217, sample B107a, ×140.
FIG. 6. External view, female right valve, paratype Io.6213, sample B219, ×140.
FIG. 7. External view, female left valve, holotype Io.6210, sample B219, ×140.
FIG. 8. Dorsal view, female carapace, paratype Io.6211, sample B219, ×140.
FIG. 9. External view, female left valve, paratype Io.6215, sample B104a, ×140.
FIGS 10, 13. Internal view, female left valve, ×140, and muscle scars (anterior to right), ×1000, paratype Io.6214, sample B219.
FIG. 11. External view, male left valve, paratype Io.6212, sample B219, ×140.
FIG. 12. Dorsal view to show hinge bar and posterior terminal denticles, male right valve, paratype Io.6216, sample B223, ×140.

Cytheropteron grekoffi sp. nov. (p. 209, see also Pl. 13, figs 1–2)

FIG. 14. Upper Oxfordian, sample B67. External view, right side, complete carapace, paratype Io.6222, ×120.

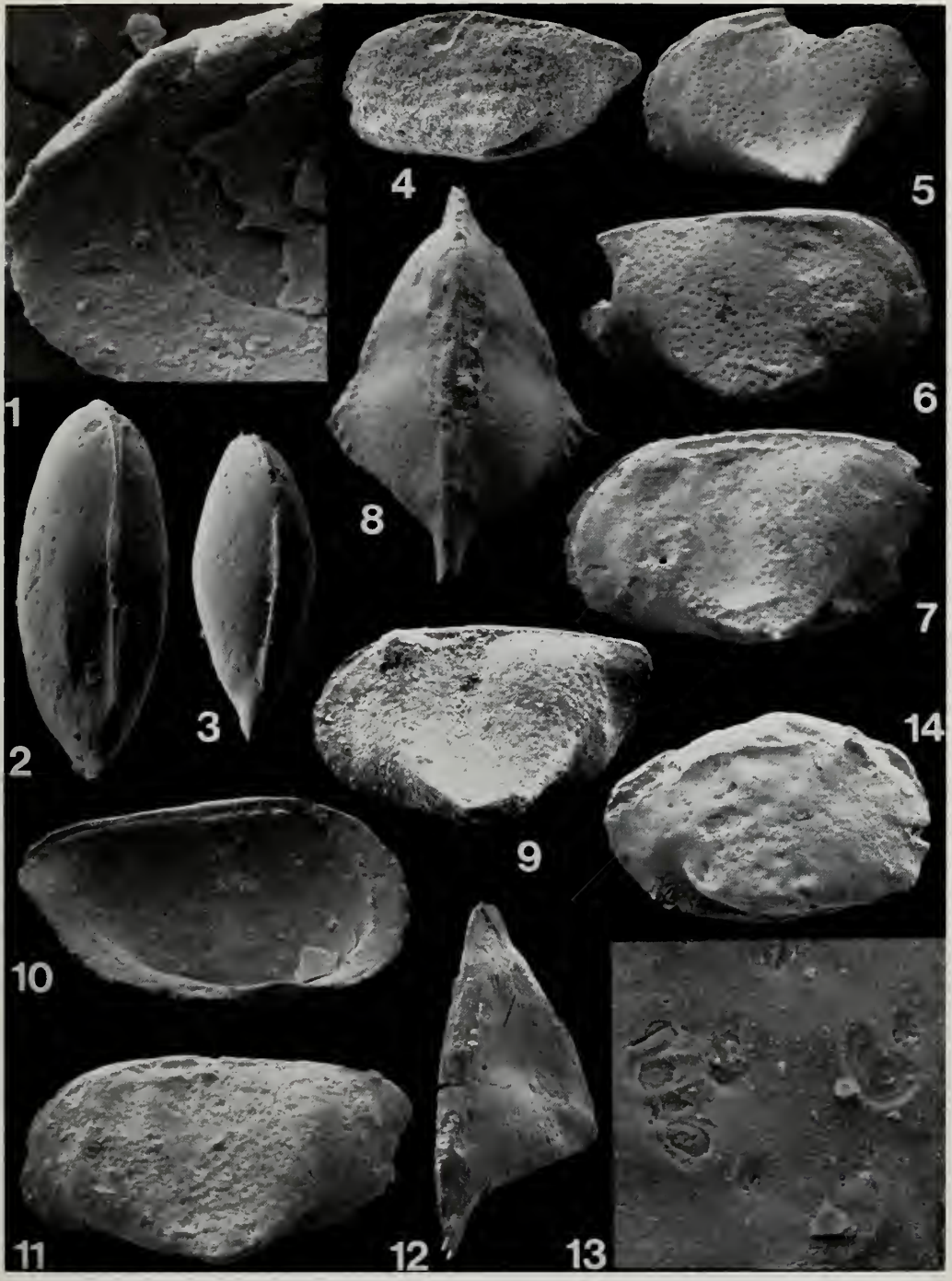
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PLATE 13

Cytheropteron grekoffi sp. nov. (p. 209, see also Pl. 12, fig. 14)
Upper Oxfordian

FIG. 1. External view, right side, complete carapace, holotype Io.6220, sample BM86, × 120.

FIG. 2. External view, left side, complete carapace, paratype Io.6221, sample B2, × 120.

Cytheropteron sp. (p. 210)
Middle or Upper Kimmeridgian, sample B223

FIG. 3. Ventral view, complete carapace, Io.6231, × 156.

FIG. 4. External view, right side, complete carapace, Io.6230, × 156.

Cytheropteron (Infracytheropteron) ndaui sp. nov. (p. 208)
Middle or Upper Kimmeridgian, sample B223

FIG. 5. External view, female carapace, holotype Io.6225, × 150.

FIGS 6, 8. External and internal views, female left valve, paratype Io.6226, × 150.

FIG. 7. Internal view, female right valve, paratype Io.6228, × 150.

FIG. 9. Internal view, male left valve, paratype Io.6229, × 150.

FIG. 10. Dorsal view, male carapace, paratype Io.6227, × 150.

Acrocythere ? tricostata sp. nov. (p. 211)
Middle or Upper Kimmeridgian, sample B223

FIG. 11. External view, left valve, holotype Io.6241, × 150.

FIG. 12. Internal view, right valve, paratype Io.6244, × 150.

FIG. 13. Internal view, left valve, paratype Io.6242, × 150.

FIG. 14. External view, right valve, paratype Io.6243, × 150.

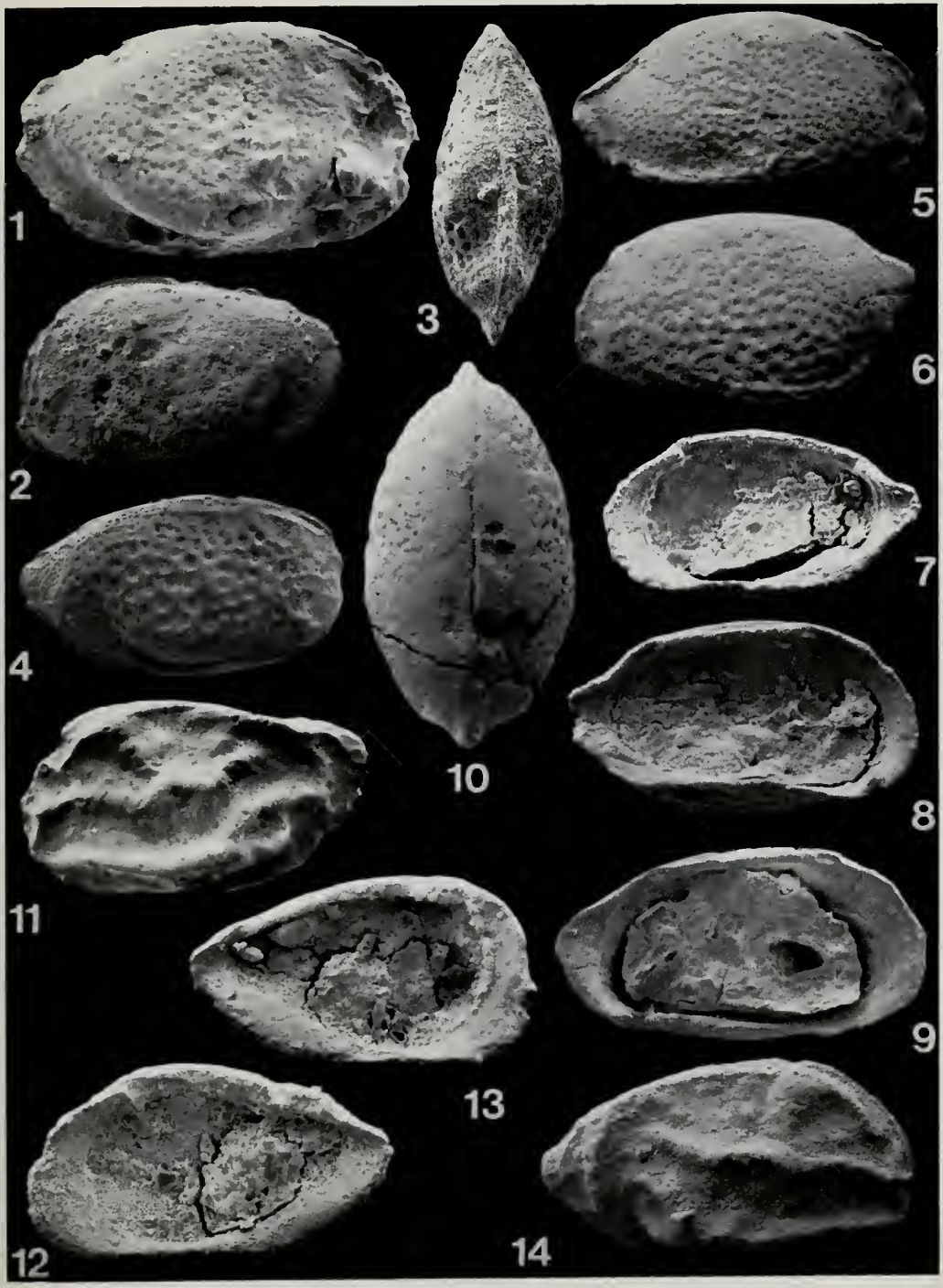
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PLATE 14

Paracytheridea mandawaensis sp. nov. (p. 210)

Middle or Upper Kimmeridgian, sample B223

FIGS 1, 6. External view, left side, complete carapace, × 150, and muscle scars × 1000, holotype Io.6233.

FIG. 2. External view, right valve, paratype Io.6234, × 150.

FIGS 3, 5. External view, left valve, × 150, and enlargement of ornamentation and of muscle scars, × 1000, paratype Io.6235.

FIG. 4. External view, right side, complete carapace, paratype Io.6239, × 150.

FIG. 7. Dorsal view, complete carapace, paratype Io.6236, × 150.

FIG. 8. Ventral view, complete carapace, paratype Io.6237, × 150.

FIG. 9. Internal view, left valve, paratype Io.6238, × 150.

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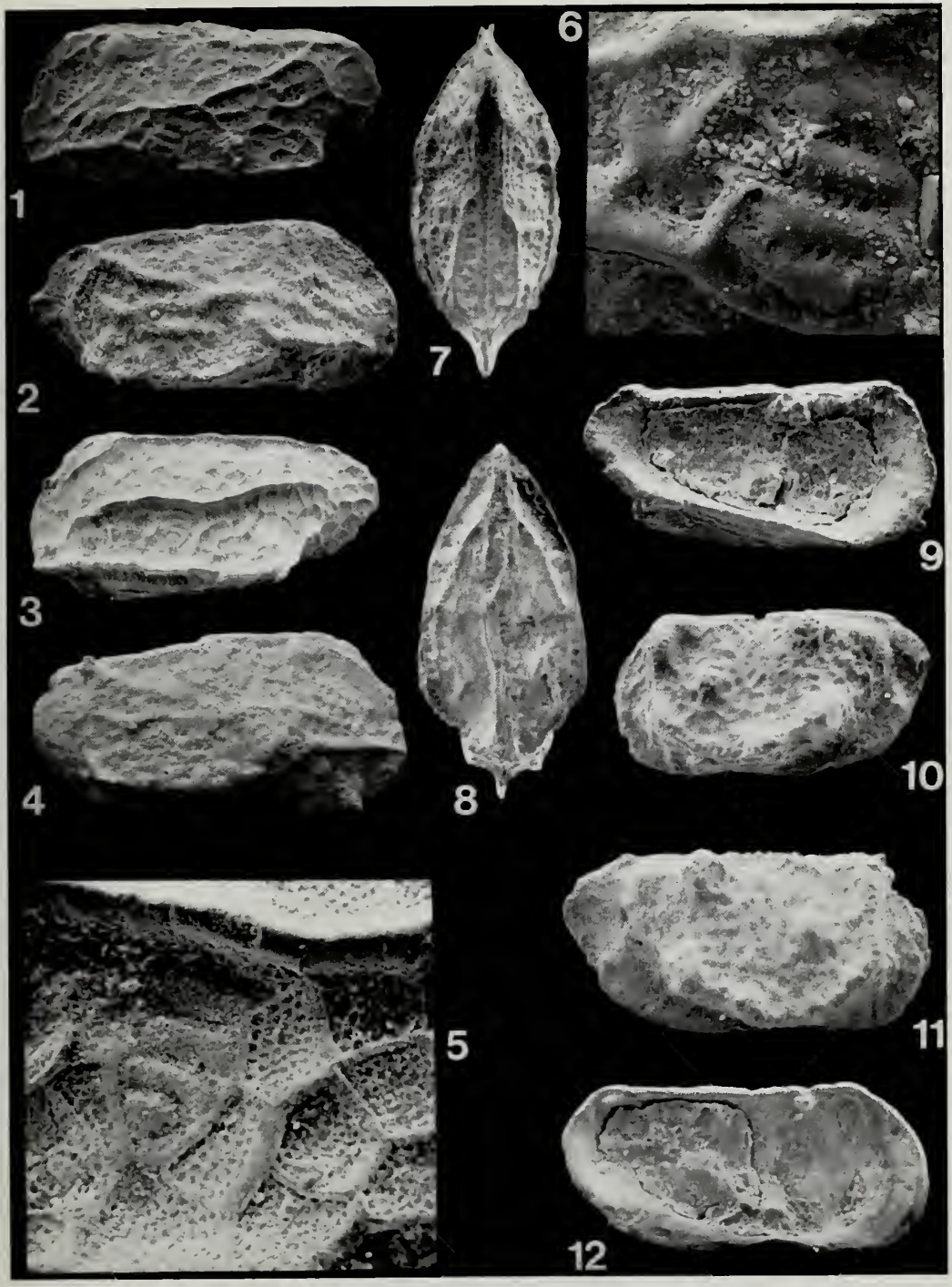
FIG. 10. External view, female left valve, holotype Io.6246, × 150.

FIG. 11. External view, male right valve, paratype Io.6247, × 150.

FIG. 12. Internal view, male left valve, paratype Io.6248, × 150.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